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EDITORIAL NOTES

INSTITUTION COMMUNICATIONS

IN this special wartime number of the "JOURNAL" we publish —of necessity in somewhat abridged form—all the Communications which were planned for presentation in London on Tuesday and Wednesday of last week. The international situation necessitated the postponement of the Annual Meeting and discussion on the Papers will in the circumstances have to be confined to written contributions; with these we shall deal later. The Communications are useful and apposite at the present juncture, many problems of immediate wartime concern being considered. A very great deal of helpful information and useful suggestion is packed in these Communications. Taking a broad view, the dominant notes struck in the contributions are (1) the need for paying much more attention to the preparation and marketing of products solid and liquid resulting from carbonization of coal as carried out at gas-works; (2) economies in process work, such as the efficient utilization of exhaust steam; (3) the need, apparent for long but definitely more urgent to-day, for a much greater measure of standardization.

The efficient running of a gas-works to obtain the maximum value in the varied substances stored in coal and liberated in the carbonizing process calls for the employment of greater numbers of technically qualified staff; it calls for imagination; it calls for a wider vision of what can be recovered from coal. In a nutshell, a gas-works is a chemical works—a point we have stressed time and time again. In his Presidential Address Mr. George Dixon speaks at some length on coke and tar and its derivatives. Referring to the formation and successful operation of coke associations he puts forward the view—which is our own—that the immediate result in the shape of more stable return to a member undertaking consequent on better marketing "falls into insignificance compared with the ultimate effects resulting in the forcing of all works to exercise greater care in producing a more carefully graded fuel . . . suitable for all prospective markets. . . . Our enforced attention to the needs arising out of the war must not be allowed to overshadow the importance of the technical side of better coke production."

There is, too, what we consider a very significant passage in the Communication by Messrs. Henshaw and Cooper. It is this: "One has heard in the past expressions of surprise at the lack of consideration shown to the carbonizing industries in view of the services rendered to the country in the last War not only in their normal duty of supplying gas, but in their power of supplying residuals. *Will the Gas Industry be able to claim such consideration if it only produces those residuals which cannot very well be avoided?*" The italics are ours. Until lately—and we include the early months of the present war—there was a great deal of discussion as to the advisability of recovering benzole from gas. Wartime demands have rendered such discussions ridiculous for the time being, but even in happier circumstances two advantages of recovery were apt to be ignored or undervalued—freedom from naphthalene and reduction of organic sulphur content in gas. The same Authors point out that intensification of gas selling propaganda will, if successful, produce the same conditions as result from the removal of benzole. Gas may conceivably be sold at a low price which will displace some of the gas undertaking's own coke. "Do undertakings," they ask, "put out two salesmen for coke as against one for gas?" Only last week in these columns we commented on the position which may arise, owing to the cessation of supplies of natural bog ore from Holland, and to other demands, in regard to oxide purification. We referred to alternative processes of ridding gas of hydrogen sulphide. Messrs. Henshaw & Cooper, whose Paper deals in turn with condensation and heat economy, tar extraction, ammonia recovery, gas washing, effluents, benzole, use of exhaust steam, controls, organic sulphur, purification, and tar distilling—a by no means small bill of fare—also refers to this question, and suggests that a case might be made for partial liquid purification at the moment as an emergency measure.

This brings us to the question of standardization—a major theme of the Communication by Mr. Haynes on Gas Meters. His recital of the outcome of past efforts to effect a measure of standardization in meter design in the interests of economy in manufacture makes sorry reading. It is nearly twenty years since the standard meter was recommended. Its advantages, however, were not appreciated by the Gas Industry as a whole, with the result that the manufacturers had to build and stock the additional patterns of meter without any of the old patterns becoming obsolete. Then came the high capacity and later the small high capacity meter. Both patterns found favour among sections of the Industry only. Again the manufacturers became overburdened with the number of different patterns. Then there were the demands of individual gas engineers to meet so-called local conditions. The matter was ventilated freely enough at a meeting of the Institution in the November of 1935, when the Meters Committee presented its 1st and 2nd Reports—the latter being the Institution Specification for Gas Meters for Domestic Consumers. It was pointed out that unless the Specification was generally adopted by the Industry the desired reduction in the number of classes and sizes of meter would not be effected and the position, instead of being improved, would be further complicated. Presenting the Reports, Mr. Terrace expressed the hope that adoption of the schedules would lead to reduced costs. "Unfortunately," remarks Mr. Haynes in his Paper, "they have not as yet been accepted by the whole of the Gas Industry, and the efforts at standardization have met with little success." It is obvious that a firmer stand is needed. Two other matters dealt with by Mr. Haynes call for particular attention—overloading of meters and the need for regular lubrication. Overloading of a new meter may have only a small effect on unaccounted-for gas. The same degree of overloading on an old meter can cause very severe losses in revenue—far more than would pay for a larger meter. As for lubrication, a small oil-gun, it is suggested, should be added to the equipment of maintenance fitters. The cost of regular lubrication would be small and would be more than repaid by preventing slow registration and loss of revenue by saving of expenditure on meter changing, and by lengthening the life of the meter.

We have left mention of Mr. Cook's Communication on the New Gas-Works at Blackpool to the end of this note simply because the Paper is more in the nature of a peacetime contribution, though it is none the less interesting for that. The removal of the gas manufacturing plant to a new site was surrounded by unusual circumstances which are fully explained in the Paper. In any case the design and construction of a new works is a somewhat rare event even in days of peace. The design and layout of the new works, and the various units of plant installed, express the modern spirit, the architectural features of the various buildings being in harmony with current thought and of a nature calculated to raise the prestige of the Gas Industry in the eyes of the public. The Paper is a record of work carefully planned and equally systematically executed. The Blackpool Corporation can feel proud of its Gas Undertaking.

GAS A.R.P. SIGNS

REFERENCE was made in our columns last week to the revision of the British Standard Specification for A.R.P. Signs, first issued in November of last year. The original specification laid down the size of the signs and the standard wording to be used, but the degree of illumination was referred to only in general terms. The revised specification goes much further than this. The clauses dealing with the brightness and the control of light have been amplified and details of the method of testing signs for compliance with these clauses are included ; and it will be agreed that this is a particularly useful addition.

The new specification will, we feel, be welcomed by the Gas Industry in general and not least by the firms within the Industry which have for long specialized in the manufacture of lighting equipment and more especially of recent years have extended and perfected their research and technical organizations and services—services which have been freely given to gas undertakings and which have been of immeasurable value in the retention and development of the public lighting load by gas. The manufacture to specification of A.R.P. signs calls for just that manipulative ability and technical skill which these firms have built up, and support by gas undertakings and local authorities of these firms is the best possible way to ensure successful installation results and also to ensure continuity of their farsighted policy.

There may have been, and probably is, a tendency for "outside" firms—we use the term in no derogatory sense—to be attracted to the manufacture of this special A.R.P. gas lighting equipment, without, in some cases at any rate, being fully appreciative of the class of work involved and the order of illumination laid down as maximum. Where doubt may have existed until now of the precise requirements of the standard signs in this respect, any cause for it has now been removed by the publication of the revised specification to which we refer. Obviously only signs complying with the specification should be purchased by gas undertakings or local authorities ; and, as we have said, firms within the Gas Industry have built up the necessary technique and have the needed facilities for the manufacture of signs conforming to the standards laid down. They could have no fear of being unable to comply with the levels of illumination prescribed or of putting out uniform equipment. It may be mentioned that the brightness of the illuminated portion of the sign has to lie between 0·04 and 0·1 equivalent foot-candle when measured in accordance with the method of test described in the specification. The maintenance of this standard can present no difficulties to firms within the Gas Industry catering for wartime street lighting having an average illumination at road level of 0·0002 foot-candle and a maximum at any point of 0·0004 foot-candle. For this reason alone it is surely logical to place orders with firms within the Industry which have the necessary experience in the application of sources of light, and whose services will be called upon by the Industry in the solving of post-war problems.

A STRAIGHT LINE

WITH business affairs so deranged as is the case to-day, study of the financial operations of industrial undertakings is likely to prove less exhilarating than usual. But amidst the many unavoidably unsatisfactory features there are to be found facts that are both excellent in themselves and of good augury for the future. While it would be folly to minimize by one iota the difficulties we are up against, it is a good plan—and perfectly justifiable—to dwell a little more than might be done in normal times upon the brighter side of things. In spite of rapidly mounting costs, as well as other difficulties, there has been a "brighter side" to the operations of many, or most, gas undertakings, even since the war began. For example, the latest accounts of Associated Gas and Water Undertakings, Ltd., made up to March, include some months of actual war conditions, but the dividend record remains "a straight line." It will be noted from the report of the proceedings at the annual general meeting appearing on later pages of this issue of the "JOURNAL," that the net profit of £74,574 (which is within a few hundred pounds of the figure for the preceding twelve months) permits the payment of a dividend at the rate maintained since the inception of the Company six years ago—*i.e.*, 5% per annum. This leaves an undivided profit to be carried forward of £32,551, an increase of £9,791 over that of a year ago.

This is a sound performance for a period, some portion of which has been overshadowed by the war, even though it be admitted, as the Chairman, Mr. W. H. Bennett, pointed out at the meeting, that, situated in urban and rural areas, largely residential, throughout Southern England, the undertakings operated by the Company are in normal times less affected than many other districts by industrial depression and artificial trade expansion, while under war conditions they enjoy the advantages of being "reception areas." Sales of gas and numbers of consumers have increased, while a similarly satisfactory position exists among the undertakings which supply electricity as well as gas. So long as it remained possible, the Company continued their policy of expansion, and a further three undertakings, all situated in the western group, were acquired during the year. This brings the total number of associated undertakings to 25. Altogether Mr. Bennett's plain, unvarnished review, while in no wise omitting recognition of the more sombre side, should strengthen the courage of the proprietors, and others who study it, in taking the longer view.

CAPITAL REQUIREMENTS

THE question of the "straight line" in the matter of dividend —alluded to in the above article—occurs to one also in connexion with the remarks of the Chairman, Sir David Milne-Watson, at the annual meeting of the South-Eastern Gas Corporation, which was reported in the "JOURNAL" for May 15. Not so well situated to withstand war effects in the case of some of the undertakings controlled by them, the Corporation experienced an immediate decrease in the gas output of those near London and in other vulnerable areas. In more than one instance the decrease was very severe, while undertakings on the Kent coast were also seriously affected. Happily, although a proportion of the undertakings controlled by the Corporation suffered in this way, Sir David pointed out that a great advantage of the grouping of companies over a wide area at once became apparent, as there was no similar loss in consumption in the inland and rural areas concerned. There was, in fact, apart from the loss of public lighting, a tendency for the sale of gas to increase, on account of additional residents. During the pre-war portion of the year, the output of gas by nearly all the Companies was above that of the corresponding period of 1938; the average increase of the whole of the undertakings over that period being 5½%. The year was not, however, to fulfil its promise, and where sudden heavy drops in sales occurred on the outbreak of war there was a serious loss in revenue with no corresponding saving in expenses. As a result, the dividend for the twelve months is 5½%, which compares with 6% paid in previous years; the carry-forward showing an increase of about £4,000 on the amount brought in.

Here the circumstances have been different, and the Directors of the Corporation consider it right that, when the price of gas has to be substantially increased, shareholders should help to meet the extra costs by suffering some reduction in dividend. But, at the same time, as Sir David reminded the proprietors, it would be unwise to lose sight of the fact that in the long run it is to the advantage of consumers, as well as shareholders, that reasonable dividends should be paid on ordinary capital invested in essential public services, so that money required for future development can be obtained on favourable terms. Readers will be aware of the steps that have been taken to meet the position. During the past year two further Companies were added to the Corporation's group, bringing in another 70,000 consumers.

WHERE GAS SALES INCREASED

MENTION has been made of increases in gas sales in urban and rural areas of Southern England. In the "JOURNAL" for May 8, similar good news was reported by the Severn Valley Gas Corporation and by the South-Western Gas and Water

Corporation. In the first case, the increase was, as Major Julian Day, the Chairman, said, because this section of the country is, in most localities, a reception area, and in a few localities a neutral area, while there has been a definite movement to this part of the country of new industries and an increase in population, which may not, however, be permanent. It was pointed out by Mr. R. B. H. Ottley, the Chairman of the South-Western Corporation, that in their case the increase in the quantity of gas sold is, in the aggregate, because certain of the constituent Companies are participating in the industrial demand for gas, and are also benefiting through the redistribution of population. Presiding at the meeting of the United Kingdom Gas Corporation ("JOURNAL" dated June 5), Mr. Ottley was again able to report an all-round increase in gas sales, though the Corporation were not able to show as rosy a picture as they had at one time hoped.

A study of the extended reports of the proceedings at the meetings of the five Corporations referred to in these notes is a heartening procedure during the present trying times. It is not so very difficult to realize, to some extent, the loss in public service that would be entailed were a brake applied to the activities of the Corporations through difficulties being encountered in the raising of necessary capital. For the time being, these activities are perforce curtailed, but when the road of progress is once again clear the policy must be one of continuous expansion. Unless ordinary dividends are maintained at a fair rate—we will not go so far as to use the word "tempting"—investors cannot be expected, when the time comes, to tumble over each other in their rush to subscribe for fresh issues of ordinary capital, while the terms upon which preference capital could be secured must be very unfavourably influenced.

Central Register

In the Spring of last year members of The Institution of Gas Engineers resident in Great Britain were invited to enrol on the Central Register of Persons with Specialist Qualifications being compiled by the Ministry of Labour and National Service with the help of the professional organizations. We referred to this in the "JOURNAL" of April 5, 1939, expressing the hope that the response on the part of gas engineers would be general and immediate. Perhaps at the time some engineers did not feel able to agree to enrolment. In the present crisis, however, it is essential that the record should be complete to ensure that the services of professional engineers shall be used to the best advantage in the national interest. Last week an appeal was made by the Minister to those who may not have enrolled to do so without delay. For the efficient operation of the Register members of the Institution are asked to keep the Institution informed of any change of address or employer and any additions to existing professional qualifications.

Packing Materials

In view of the urgent need for the most rigid economy in the use of packing materials and of their rapidly increasing cost, the makers of gas appliances are appealing to gas undertakings to collaborate with them in an effort to utilize existing stocks to the greatest possible extent. Gas undertakings are requested to ensure that all such materials including paper, corrugated cardboard, small boxes, and cartons are placed in the empty crates and packing cases and returned to the firm by whom the goods were dispatched. It is clearly in the national interest that the widest possible co-operation should be achieved within the Gas Industry in economizing in packing materials, and we have no doubt whatever that this co-operation will be forthcoming.

Forthcoming Engagements

June.

15.—Western Juniors.—Meeting at Taunton.
18.—B.C.G.A.—Meeting of Executive Committee, 10 a.m.
18.—I.G.E.—Gas Education Executive Committee, 2 p.m.
28.—Waverley Association.—General Meeting, North British Station Hotel, Edinburgh.

July

5.—Manchester District Association.—Visit to Stockport.
13.—Western Juniors.—Summer Meeting at Minehead.

August.

13.—Irish Association.—Annual General Meeting at Dublin.

Personal

Mr. A. Bird having been Manager for 46 years, the Directors have appointed his son, Mr. J. S. BIRD, Joint General Manager and Secretary to the Bromsgrove Gaslight and Coke Company. Mr. J. S. Bird, after leaving Bromsgrove School, went to Messrs. Drakes, Ltd., Halifax, for five years, going through the shops, drawing office, and outside erections, and for the past ten years he has been Assistant Engineer and Manager to the Bromsgrove Company.

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Mr. G. FITTON, of Wakefield, has been appointed Works Manager of the Swindon United Gas Company. He gained his B.Sc. in Chemistry at London University and started his professional career in the chemical industry in his native town. Later he served a term of articles with the Dewsbury Corporation Gas Engineer. Subsequently he was for 18 months Assistant Engineer to the Stroud Gas Light and Coke Company, and from there he returned to Dewsbury as Deputy Engineer and Manager, a post he held for three and a half years. Mr. Fitton is 27 and an Associate Member of The Institution of Gas Engineers.

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The Chesterfield Gas Committee have appointed Mr. V. E. PEEL, of Morecambe and Heysham, to the post of Assistant Engineer and Manager of the Chesterfield gas undertaking.

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Mr. MASON, for eleven years Assistant to the Engineer and Manager of the Kendal Gas and Water Department, has been appointed Technical Assistant to the Clacton-on-Sea Gas Department.

This is the fourth moval from Kendal in the past two years. Mr. L. Wilson is now District Manager of the Watford and St. Albans Company, Mr. P. Dawson is Chief Assistant at the Wisbech Water and Gas Company, and Mr. J. Kelly is Chemist at the Plymouth Gas Department. All served their Articles under Mr. Thomas Crowdy, Engineer and Manager of the Kendal Corporation Gas and Water Department.

Mr. P. R. DAVISON, Distribution Superintendent at Kendal, has been appointed Chief Assistant to Mr. Crowdy. Mr. Davison was trained at the South Shields Gas-Works, and has been an energetic worker on the distribution side for some years. He holds the Higher Grade Certificates, First Class in Gas Engineering and Supply.

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Alderman G. H. BARBER was entertained to luncheon by his colleagues on the Gas Committee of the Stoke-on-Trent City Council at the Grand Hotel, Hanley, on May 31, when he was presented with a badge in commemoration of his 80th birthday recently. Mr. A. E. Hewitt (Chairman of the Committee) presided at the luncheon, which was of a private character. The presentation was made by the Chairman and consisted of a gold badge, with the City Arms in enamel and gold, surrounded by the words "City of Stoke-on-Trent Gas Department" on the front, while on the reverse side is the inscription, "Presented to Alderman G. H. Barber, J.P., by the Stoke-on-Trent Gas Committee on attaining his 80th birthday and in recognition of 29 years' service on the Gas Committee."

Alderman Barber has been a member of the Committee since 1910 and played a prominent part in the negotiations which led to the purchase by the Corporation of the British Gas Light Company's undertaking in the Potteries. He was Chairman of the Committee for a short period.

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Mr. CLIFFORD A. KING, Managing Director of Walter King, Ltd., has been called up from the Army Officers Emergency Reserve, in which he was registered in April, 1938. Mr. King served with Commissioned Rank in the Royal Engineers from January, 1915, to December, 1919.

Obituary

The death has occurred in his 70th year of Mr. ANDREW DICK, a Director of the Lochgelly Gas Company. He was a former Magistrate on the Lochgelly Town Council.

In memory of the late Mr. George Wilks, General Manager and Secretary of the Watford and St. Albans Gas Company, a memorial fund has been opened and the Company and employees have contributed £200. It is known as the "George Wilks Memorial Fund," and the Co-partnership Committee have agreed to send the whole of it to the Bedford Institute, with the suggestion that the income shall be employed in sending away each year, to the seaside and country, some of the children from the Hoxton Hall Mission, in which Mr. Wilks was so deeply interested.

COPPER AND COPPER ALLOYS FOR GAS APPLIANCES

AN announcement has been made by the Controller of Non-Ferrous Metals that owing to the present very heavy demand for copper and copper alloys it is of the utmost urgency that the use of these materials for non-essential purposes shall be eliminated, and their use for other purposes be reduced to a minimum by the use of substitute materials wherever possible.

The announcement goes on to state that in order that more definite guidance may be given in this matter the employment of copper and copper alloys in the production of the articles mentioned below will in future be restricted, except for minor parts for which no substitute can be employed and for the plating or brazing of steel parts where this is necessary. The restriction applies to all goods except those manufactured for export or to Ministry of Supply, War Office, Admiralty, or Air Ministry orders.

(a) From the date of this communication and until further notice no more licences will be granted, except in very special circumstances, for copper or copper alloys for the manufacture of the following articles: Ornamental lighting fittings of all types, including table and standard lamps; lighting reflectors, shades, galleries, and shade carriers; reflectors, guards, and ornamental parts of bowl and other types of gas fires and heating appliances; tube connexions from points to fires.

(b) The weight of copper and copper alloys to be used by any manufacturer in the production of the following articles will be determined as follows:

Raw material licences will be granted for the four months commencing June 1, 1940, to an extent not exceeding 25% of the tonnage used by the manufacturer during the same period in 1939 for home civil orders only.

Gas water heaters of all types.

Wash boilers and washing machines.

Whenever copper or copper alloy products are required for the manufacture of any of the articles mentioned above under headings (a), or (b) for service orders, a statement to this effect must be made by manufacturers to their suppliers and be included by the latter in their applications for licences to purchase the necessary raw materials.

Particular attention is drawn to the vital necessity at the present time for the exercise of special care in the salvage and repair of all types of apparatus and appliances in order that new replacements may be eliminated wherever possible. If repair cannot be effected the materials scrapped should be suitably graded and disposed of without delay.

All firms adhering to the above scheme must quote the symbol "N.F.G." when ordering from their suppliers, who must in turn quote the same symbol on the schedules which they submit to the Non-Ferrous Metals Control. The use of this symbol by any firm is to be regarded as an undertaking that the conditions set out above are being fully observed. No application for metal will be considered unless the symbol is quoted.

NEWS OF THE WEEK

Ex-Soldiers on the Staff of the Blackburn Gas Department are to be enrolled as Local Defence Volunteers for the protection of the undertaking during the war.

The Newly Formed Blackburn Gas and Electricity Joint Sales Committee have appointed Coun. W. Tempest as Chairman. The appointment of the Committee follows the decision of the Town Council to revise and co-ordinate the policy of the two undertakings.

Under the Auspices of the Falkirk Corporation Gas Department, gas cookery demonstrations were given by Miss Ivy W. Sketchley, M.C.A., of the Forth and Clyde and Sunnyside Iron Companies, Ltd., in the Gas Showrooms, High Street, Falkirk, twice daily from June 10 to June 14.

The Mobile Canteen which the Women's Gas Council has presented to H.M. Forces is going to be used in Manchester, and arrangements have been made for it to be on view at Gaythorn Gas-Works to-day between 2.30 p.m. and 4.30 p.m. The Lady Mayoress of Manchester (Mrs. G. Harold White) promised to be present at the inspection.

Miss A. M. S. Wilson, B.Sc., of the Women's Gas Council, spoke for the Ministry of Food at a meeting held in the Mayor's Parlour, Cheltenham, on Thursday, June 6. The meeting was called to inaugurate the Food Education Campaign in the town, and leaders of all the Women's Organizations in Cheltenham were present. Alderman Clara Winterbotham was in the Chair.

The General Meeting of the Gas and Coke Making Equipment Export Sub-Group which was to have been held in London on June 5 will be held at the Midland Hotel, Manchester, at 2.30 p.m. on Tuesday, June 18.

New Rates for Large Industrial Users have been introduced by the Halifax Gas Department. The Committee had been approached to see if there could be amended prices for greater consumption. Two works were contemplating extension and were uncertain whether to use coal, oil, electricity, or gas. The Committee decided to introduce additional blocks, giving a reduction of 2d. per 1,000 cu.ft. in the price of all gas used between 2,000,000 and 4,000,000 cu.ft. per quarter, making the net price 1s. 10d. per thousand, and a further reduction of 2d. (to 1s. 8d.) per thousand for all gas used in excess of 4,000,000 cu.ft. per quarter. One large firm taking 17,000,000 cu.ft. per annum will save £80 on their yearly account.

The New Café in Battersea Park is all-gas—lighting, water heating, cooking, heating, and refrigeration are all gas operated. It is in a lovely setting. On one side, a dozen yards or so away, are some of London's least known stags whose compound is a pleasant tree-shaded hill. On the other side Londoners forget the war for a little time on Battersea Park's properly popular lake. The café, which was recently opened by Mrs. Ruth Dalton, Chairman of the L.C.C. Parks Committee, is built on functional sun-trap lines and combines modernity with comfort. The circular front is entirely of glass, with big double doors which can be folded back. One can take coffee inside or on the verandah, or, on the lawns which overlook the ornamental lake.

Elsie and Doris Waters—"Gert" and "Dais" to their radio fans—have lately assumed the role, under the Ministry of Food campaign, of guide, philosopher and friend of the housewife in her cooking problems. Their recent talks in the series called "Feed the Brute" were widely enjoyed, and we understand they are hoping in the near future to publish a cookery book of what they call "their very own recipes." For this reason it is interesting to note that they use a modern gas cooker in their cottage at Steyning, Sussex—a "New World" in white enamel finish—and the reliance they place in the automatic oven control may, perhaps, be gauged from the right-hand photograph!

INSTITUTION OF GAS ENGINEERS

In the following pages we give abstracts of the various Communications which were to have been presented at the Annual Meeting of the Institution which was planned to take place in London last week, but which, due to the international situation, had to be postponed. Written contributions to the discussions are invited and will subsequently be published in the "JOURNAL"

Presidential Address

Communication No. 229 (abridged)

By GEORGE DIXON,
B.Eng., M.Inst.C.E., M.Inst.Gas E.,
Engineer and Manager, Nottingham Corporation Gas Department

MY first words to you must be of sincere thanks for your loyalty and friendly sympathy during the year, and of my hope that my successor may be privileged during the next twelve months to preside over you during a change-over from war to peace conditions and to set you on a course of scientific progress which has been prepared, and upon which we had hoped we should already be engaged had it not been that our Country had been called upon to defend its most treasured policy of freedom of the individual.

I must speak to you to-day in more general terms than usual and I take advantage of the situation to discuss some of the more domestic matters concerning our Institution in the hope that more of the members may be induced to take a greater active interest in its work.

Education

In the year 1923 the Education Scheme of The Institution of Gas Engineers was inaugurated, and its present state of usefulness to those entering our profession must always stand as a monument to those pioneers who were responsible for its formation.

The subjects included today in Gas Engineering (Manufacture) and Gas Engineering (Supply) are so varied that a syllabus to cover a complete course has only been designed after most careful consideration, and it is a happy augury for the future that men who have been given freedom of choice have presented so very wide a variety of subjects for the theses they have submitted for their Diploma Examination.

It is disappointing to note that in the 16th Report of the Gas Education Committee the examiners state: "The methodical answering of a question, that is, concisely, logically and, where possible, supported by figures and sketches, cannot be stressed too strongly, and there is still much to be desired in this respect." This weakness should be remedied. It continues to be evident throughout a man's career and attention has been drawn repeatedly to the serious effect on an assistant's work of inability to set out his results in a manner that enables a quick and accurate summary to be drawn.

The President

The remedy goes further back than the Final Examination and although we should hesitate to add yet another subject to the list of ancillary requirements, the Education Committee might be well advised to give some consideration to the inclusion of some instruction in Economics and the setting out of results—subjects that prove of increasing value with every year spent and every advance made in the profession.

Another matter that has always appealed to me as worth while is the advisability of the District Education Committees keeping a census of prospective and current students and maintaining a personal contact with them to ensure that they are following a course of study that will meet the requirements of the standards set by the Education Scheme.

One of the most interesting pointers to the future is the changing personnel in our Industry, as illustrated by the membership of the Institution.

The number of full Members shows a tendency to a slight decrease due to the passing of old friends and the decrease in the number of smaller individual Gas Undertakings as the result of amalgamations, there has been a marked increase in the numbers of technically qualified younger men as represented by the Associate Membership class.

Since the date of the Royal Charter, the value of the Education Scheme as a means of attaining the requisite professional qualification necessary to satisfy one of the conditions of corporate membership of the Institution has been realized by young men determined to advance in their profession, and has resulted in a steady flow of applicants for the Associate Membership class, which has advanced in numbers to the figure of 665 on 31st December last. The significance of this increase is encouraging for the future. It points to the growth in numbers of well-qualified, young and enthusiastic workers, ready to carry on the specialized work of the many branches of scientific research which has long outgrown the scope of the former body of what may be termed "general practitioners".

The very nature of the development of the technical side of our Industry demands the co-operation of a group of specialists; and the growth of team spirit to enable the best results to be obtained is one of the proudest achievements of recent years.

In order to ensure the effective continuity of this work, attention is drawn to the necessity of recognizing the urgent need of fair and proper remuneration for services rendered. It is admitted, however, that whilst this subject has had consideration in the past, progress has been hampered by the lack of educational standards by which merit could be judged.

The Education Scheme has thus done much to bring about standardization of qualifications which may well enable employers to adopt a more satisfactory scale of salaries.

It would appear necessary to point out that the passing of examinations is only one of the qualifications required for corporate membership under the Institution's Constitution. Such qualification must be accompanied by satisfactory evidence of practical experience and the holding of a position which warrants the Council conferring the honour of inclusion in the list of Corporate Members.

The Institution of Gas Engineers

The accompanying chart (Figure 1) shows the structure of the Institution and its relationship with other organizations and affiliated bodies. Attention is drawn to the inclusion of the new Gas Research Board and the link with the Society of British Gas Industries. The Chairman's Technical Committee—the successor to the old Research Executive Committee—is also shown, and this is referred to again later under the heading of the Gas Research Board.

Notes on the structure of the parent body cannot be complete without some reference to, and appreciation of, the work done by the District Associations, both Senior and Junior. It

cannot be denied that in our Industry the London viewpoint or the London condition is not necessarily the same as that of the Provinces, and the opportunity offered through the direct District representation on the Institution Council, or through Papers submitted, or opinions expressed at Meetings of the District Associations, is a most welcome factor tending to keep all viewpoints in proper perspective.

It is always a matter of regret to me that it has never been found practicable to make the District Associations into more directly linked "Sections" of the Institution, at Meetings of which the work being done by the Parent body could periodically be reported to the District members for their information and criticism.

for no less than 44 per cent of the total income of the Institution.

The Gas Research Board

The activities of the Gas Research Board during the past year have of necessity, in these early stages, been devoted partly to administrative procedure in addition to its normal work of research.

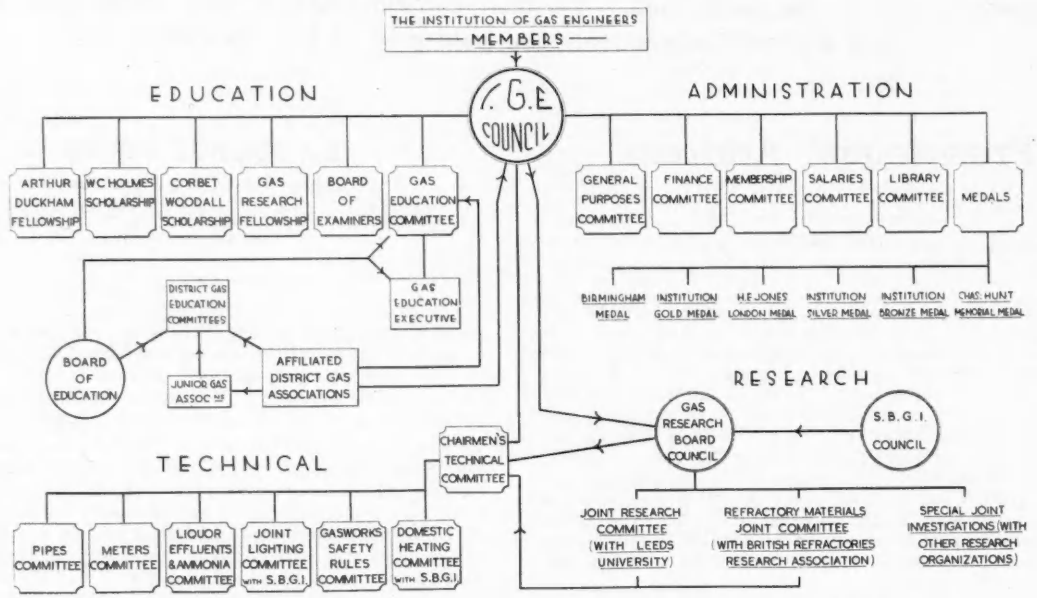


FIGURE 1.—*Structure of The Institution of Gas Engineers and Its Relationship with Other Organizations and Affiliated Bodies.*

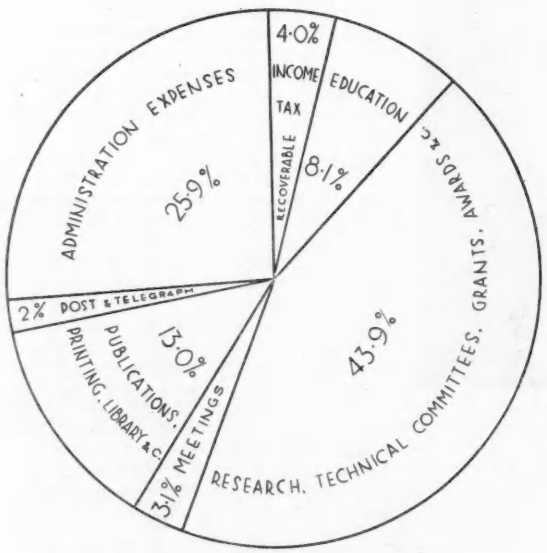


FIGURE 2.—*Allocation of Expenditure, year ended 31st December, 1939.*

This allocation includes all expenditure, both on account of the general work of the Institution and of the Special Purposes Fund.

The allocation of the money controlled by the Institution is of passing interest and a diagram is therefore appended (Figure 2) showing the proportion being expended under each main heading.

It is indicative of the increased amount of research and technical work that expenditure under this heading accounts

The administrative procedure has been that the Council of the Board has approved its Constitution in the form of Memorandum and Articles of Association for incorporation under the Companies Act, 1929. The Constitution provides, *inter alia*, for approach to the Department of Scientific and Industrial Research for the provision of Government assistance at such time as the Council may at its discretion decide.

One or two other points from the Constitution are also of general interest. There are to be a President—the first being Sir David Milne-Watson—and two Vice-Presidents of the Gas Research Board, one Vice-President being nominated by the Council of The Institution of Gas Engineers and one by the Council of The Society of British Gas Industries. Another provision to which attention is drawn is that members of any class of The Institution of Gas Engineers, providing their employers are Members of the Gas Research Board, may become Associate Members of the Board upon such terms as the Council of the Board may decide. The value to members of the Institution of this provision is important, since those who became Associate Members of the Board will be able to receive the confidential reports and publications on research, as distinct from those reports which may be made public, which may be circulated only to members of the Board.

Turning now to the progress of the Council of the Board in regard to Research, at the end of 1939 the Gas Research Board, at the request of the Council of the Institution, took over the conduct of research which had hitherto been under the direction of the Research Executive Committee. The work of the technical committees of the Institution, namely, the Domestic Heating Committee, the Gas Works Safety Rules Committee, the Joint Lighting Committee, the Liquor Effluents and Ammonia Committee, the Meters Committee and the Pipes Committee, is being continued as heretofore. A new Committee, called the Chairman's Technical Committee—the members of which are the respective Chairmen of these Committees, together with the Chairmen of the Joint Research Committee, the Refractory Materials Joint Committee, the Gas Industry Committee of the British Standards Institution, and the Director of Research of the Gas Research Board—has been formed to co-ordinate the work of the technical committeees and to report on them to the Council of the Institution, and to maintain close contact between the technical work of the Institution and the research investigations of the Gas Research Board.

The Council of the Board has also been occupied with matters arising directly out of the war. In this connexion, the Council of the Board, with the approval of the Council of The Institution of Gas Engineers, has in the name of the Institution, and through the Acting Director of Research, established valuable contacts with Government Departments so that any special help required from the Gas Industry towards winning the war may be most speedily rendered.

Coal Conservation

Every ton of coal carbonized at the Gas Works will produce gas and coke that will do the work of one and a quarter tons of coal used as raw fuel—a saving of 20 per cent. With the possibility of most of the resultant coke being used within easy distance of the carbonizing centres, the relief to our overburdened coal transport system conjures up a prospect that cannot but attract the serious attention of those responsible for efficient economic government.

It is gratifying to acknowledge the increasing interest taken in our Industry by the scientific fuel departments of the Government. We welcome their co-operation, and are happy to place the benefit of our experience and research at their disposal. We recognize a common aim and we court their confidence so that they will consult with us in their endeavour to solve the problems in relation to all fuel matters.

If we are to be encouraged in our aim at coal conservation, our friends in the coal industry must realize the necessity for freedom of choice of coals best suited to our particular local conditions, type of plant used, calorific value of gas, local coke demand, etc. The coal selling schemes have not been helpful and they have been the cause of the neutralization of many of the advantages which were the reasons for the original selection of type of plant, etc., being installed.

Most of us when selling gas have to design tariffs which will enable us to offer attractive prices for the particular use to which the gas has to be put.

The coal industry should recognize that coals should be permitted to be sold at such comparative prices as will prove economic to the consumer under the conditions in which the coal is to be carbonized.

As a case in point, my Undertaking's natural geographical source of coal supply is the Nottinghamshire and Derbyshire coal-field, but although these coals vary considerably in their relative value to Nottingham, the coal selling authorities demand practically the same delivered price for each quality—nor are we permitted to buy from pits of our own choosing even at the prices fixed by the collieries.

It would seem desirable for a comparative value to be ascertained for all coals by some independent body such as the Government Coal Survey Department, leaving the consumer free to purchase as best suits his purpose under his own conditions.

Coke

There is little need to stress the importance of the incidence of coke revenue upon the net cost of gas, and we may be encouraged by the successful formation of both gas coke and hard-coke Associations throughout the Country, following the lead of the London and Counties Coke Association a few years ago. The immediate result, however, in the shape of more stable return to the Undertaking consequent upon better marketing, falls into insignificance compared with the ultimate effects resulting from the forcing of all Works to exercise greater care in producing a more carefully graded fuel, lower in ash and moisture content, and suitable for all prospective markets.

Much of our success depends upon the co-operation of our friends in the coal industry to clean the coal sent out from the pits, and much again depends upon the choice of suitable coals for proper blending to suit the type of carbonizing plant available; but given freedom of choice by the coal selling committees, and anticipating their appreciation of the importance of the matter to us as Public Utility Undertakings, there is no more hopeful subject in hand than the investigation into the technical problems connected with our main by-product.

The slow-moving but long overdue appreciation of the importance of the abolition of the smoke nuisance is gradually forcing itself upon the "man in the street", and our Industry can do much to hasten the influence of public opinion by the physical improvement of our smokeless fuel and by energetic research into the problems connected with its better utilization.

Our enforced attention to the needs arising out of the war must not be allowed to overshadow the importance of the technical side of better coke production. We are not short of man power to tackle the subjects outstanding, and such communications as that from our Liverpool friends on the activation of coke are most timely and valuable. If we can improve our products so that we can combine high radiant efficiency with better ignitability and combustibility we can claim to be on the threshold of the attainment of yet another achievement that will benefit our consumers, our Industry and our Country alike.

The enthusiasm for, and participation in, the benefits of the work of the Coke Associations must not be confined to a part only of our engineers. No coke must be produced that does not bear the hall-mark of efficiency.

Tar and its Derivatives

I am often tempted to ask why all Undertakings do not appreciate the value of the tar products from the normal carbonizing process.

A study of published returns of different Gas Undertakings would appear to reveal a very wide margin in the return per gallon of tar, and the difference is not to be explained by any possible variation in the method of allocation of costs. There is evidence that those Undertakings which show appreciation of the fact that tar is a valuable product—and particularly those possessing distillation plants—show a much better financial return than those which consider their tar merely as something which has to be produced and has to be disposed of.

It is true that the gas engineer is engaged in an Industry comprising so many branches of science and engineering that he may be reluctant to add tar distillation to his duties. Moreover, the changing characteristics of gas works tar as the result of new methods of carbonization and the tightening up of specifications called for by the buyer of road tar preparations or other products demands a very high standard of chemical control and plant operation, but as our chief object is to produce gas at a price that will enable us to sell it to prospective consumers at a competitive figure, we cannot afford to lose any opportunity that presents itself of increasing our by-product revenue.

The unnecessary transport of crude tar, often containing excessive quantities of weak ammonia liquor, is a burden upon our Undertakings, and a further burden upon our transport system.

I hope I shall not be misunderstood as holding a brief for inefficient dehydration plants and the marketing of a haphazard road tar; as with gas and coke, the ability to turn out a first-class guaranteed product must be the primary consideration.

The war, necessitating greatly increased heavy road traffic, together with the lack of opportunities for the proper surface dressing and maintenance of roads, will result in a heavy demand for a suitable product in the future.

Our Industry will be faced with an opportunity for contributing to this work of reconstruction, and we must take the markets that will be offered by making sure that there is no lack of suitable plant or technical skill available.

The British Road Tar Association is doing most praiseworthy work in the preparation of specifications for tar for various purposes, and the supervision of conditions under which dressings or mixtures are applied on the site. I believe that its work would be much helped by greater support from gas tar producers as a means of sweeping from the market all tar that is not equal to the use for which it is intended.

The Small Gas Undertakings

Much has been written on the subject of amalgamations and holding companies, and, under the control that has been exercised in this country, the advantages of the scheme to the gas consumers of the smaller Undertakings cannot be denied.

The present tendency towards the formation of district group committees for mutual assistance under war conditions has centred attention upon the large number of very small Undertakings and the credit that is due to them in their work of maintaining a satisfactory quality and supply of gas, often under very difficult conditions.

Of some 1,269 Undertakings in the British Isles, no less than 556, or 43·8 per cent, have an annual output of under 30 mill. cu.ft. Some of these Undertakings are already under the control of larger ones, but the resources of the remainder are often such that they cannot afford the technical or commercial standards of control that are desirable, and they are therefore unable to avail themselves of prospective markets for gas; nor can the Gas Industry demonstrate the advantages of gaseous fuel.

There would appear to be a case for some form of district advisory boards to afford some measure of control and to

offer such assistance as may be required, to the benefit of the local consumers in particular and our Industry in general. There are certainly many cases where the Undertakings of small adjacent towns could be linked together. In other cases a scheme for mutual assistance would be acceptable and advantageous.

Benevolent Fund

As Chairman of the Committee of Management of the Institution Benevolent Fund, your President has occasion to come into close contact with the number of cases of hardship and with the difficulty of meeting the needs of these cases out of the total funds available from subscriptions, donations and interest. Thus it is that each succeeding President considers it incumbent upon him to bring the claims of the Fund to your notice through the medium of his Presidential Address.

Last year your Committee informed you of a scheme by which the income of the Benevolent Fund could be augmented very materially by the recovery of the income tax already paid by contributors.

They were asked to sign a covenant which involved them in nothing more than the obligation to pay their subscriptions for a definite period of seven years. Some 130 out of a possible 650 have expressed their willingness to take the opportunity offered to assist those of our colleagues or their dependants who are requiring financial help. With the knowledge that with income tax at the present level of 7s. 6d. in the £1, every 10s. subscribed will enable the Fund to be credited with 16s., it can surely be nothing more than a reminder that is necessary to bring 100 per cent response. It is not often that increased income can be obtained without increased subscriptions per contributor; moreover, the greater the call upon you by way of increased national income tax, the greater are you benefiting the Benevolent Fund by taking part in the scheme offered.

I trust that this appeal may be the means of greatly increased assistance being offered to recipients by your energetic Committee, which is doing a most praiseworthy work on your behalf.

Use of Gas in Industry

The extension during the past decade of the use of town gas in the industrial field has been almost phenomenal and wherever heat is used in process work gas can almost certainly be found. In the heavier industries, furnaces and equipment using gas have grown to such an extent that the demand has threatened to exceed the supply.

In the food production trade, the use of gas has no doubt been influenced to a greater extent than any other by the cleanliness associated with its use.

There appear to be encouraging prospects in the field of space heating, especially for house and office heating where the increased running cost over that of solid fuel is far outweighed by the advantages obtainable.

Of particular interest is the increasing attention being paid to various forms of radiant heating and the scientific research being directed to the degree of comfort attainable with varying air temperatures.

The Factories Act, 1937, states that a minimum temperature of 60° F. should be provided for the comfort of workpeople, but it has been demonstrated that an air temperature of 55° F., together with radiant heat sources, will provide equal, if not better, comfort conditions.

The research experiments carried out at the National Physical Laboratory with the eupatheoscope and the practical tests taken on a large-scale installation of overhead radiant heaters with the Vernon globe thermometers have shown that comfortable warmth can be provided by such heaters and that here is a wide field for development. The high-temperature overhead radiant panel is not restricted to indoor use and has in fact been used already for heating the stands at several sports stadiums. Is it therefore too much to hope that eventually the development of radiant heating may provide us with a solution of many heating problems where the increasing of surrounding air temperatures would otherwise be an economic impossibility?

In examining the factors which have been responsible for the increase of the use of gas in industry, there can be no doubt that a service of technical advice and assistance to consumers is of prime importance, and in this connexion the work of the Industrial Gas Centres cannot be stressed too highly. It should be realized, however, that few of the industrial representatives who form the Technical Committees of the various centres have either the time or the opportunity for research into the many and varying technical problems which arise in the course of their work. In consequence, trial-and-error methods prevail to a great extent and although the final result may be very satisfactory to the consumers, time has been spent either at the expense of the consumer or the Undertaking which could have been avoided had it been possible to submit the problem to an independent Industrial Gas Research Laboratory.

In saying this, tribute must be paid to those larger Undertakings which have equipped and maintained their own laboratories and have lent their facilities and efforts towards the solution of problems encountered by less fortunate Undertakings. The larger Undertakings, however, naturally are concerned primarily with the problems of their own districts, and we should consider whether the provision of research facilities on the lines of the American Gas Association Industrial Research Laboratory, to serve the whole Gas Industry, is not opportune.

Much of the development of new furnace and industrial appliances has in the past been left to the individual furnace manufacturer whose interests and co-operation in any such project could undoubtedly be secured.

The war has had the effect of greatly accelerating the use of gas for industrial purposes, and we should do well to take stock of the position in this respect. The main object of the programme is the production of armaments of as high a quality as possible at as great a speed as possible, with cost of secondary importance. Consequently there is little opportunity for the obtaining of test data on gas-fired furnaces, with the result that after the war the advantages of gas firing may not be so apparent to our consumers as we may be led to expect. It is, therefore, of vital importance that members of the Gas Industry in touch with factories on work of national importance should exert every effort to obtain the installation of modern types of gas-fired equipment.

The tendency for the future appears to be towards a clearer definition of the relative fields of usefulness of gas and electricity. Gas is likely to be increasingly used for all primary heat requirements such as furnaces, etc.

The development of heat-resisting steels will enable higher temperatures to be attained in furnaces using radiant tubes and the improvement in insulating refractories will enable furnaces to be built of rather lighter construction with little external loss.

Gas Lighting

The position of domestic gas lighting is one that deserves more attention, and it is desirable that some attempt be made to obtain a census of the magnitude of the load throughout the Country. The obtaining of such a census is obviously a difficult problem, but with the co-operation of the distribution staffs, I believe a very close estimate could be reached. It is likely that such an investigation would focus attention upon the very wide differences in load in different parts of the Country, partly to be accounted for by local conditions and partly by the degree of importance attached to the lighting load by the supply undertakings concerned.

The public lighting load is an easier problem because it is a known factor, and it is of prime significance that the annual returns should show a steady increase from year to year.

During the past ten years the consumption of gas for public lighting has grown from 10,500 mill. cu.ft. to 15,000 mill. cu.ft., in spite of keen but healthy competition from our friends in the electrical industry. Part of this increase is undoubtedly due to the extension of developed areas and part to the insistence, by the Public Authorities, on better lighting of our thoroughfares to meet the new conditions brought about by the growth of volume of faster moving traffic.

This demand is likely to open up a continually greater opportunity for our Industry, but to meet the call we must not be satisfied with the present efficiencies of available lighting fittings and equipment. Just prior to the outbreak of war the public lighting load represented some 5 per cent of the total of gas sold in this Country, and it should be recorded that this figure would have been greatly exceeded had it not been for the overdue attention that has recently been given to the improvement in design of lamps, the use of reflectors and refractors, and the recognition of the importance of better maintenance, all of which have produced a much greater amount of light without any increase in consumption per lamp.

The prospects for the future of gas lighting are not unconnected with the possibility of some radical change in the efficiency of the method of utilization of the heat energy supplied to the burner. Various writers have established that for every 100 B.Th.U. of energy input, 60 B.Th.U. are accounted for by flue and convection losses and 40 B.Th.U. by total radiation. Of this latter figure, the amount which appears in the visible spectrum is approximately 0·2 B.Th.U. What have

we done and what are we doing to improve this figure of one-fifth of 1 per cent efficiency?

It is true that the lamp manufacturers have engaged research chemists to investigate the problem, but I fear that their services as advisers and designers of lighting installations have been commandeered to such an extent by Undertakings up and down the Country that they have not had the opportunity of devoting their energy and time to the fundamental work and problems that lie ahead.

The present efficiency of lighting units is so low—in the case of both gas and electric lamps—that the prospects of betterment appear sufficiently attractive for a case to be made out for intensive research by the newly-formed Gas Research Board.

The high thermal efficiency of the coal carbonizing industries, the low cost of gas per therm, the softness of the light owing to the relatively larger size of the light source, and the fact that the combustion of the gas gives off so much of its heat to the surrounding atmosphere, provides gas lighting with many initial advantages.

The New Gas-Works of the Blackpool Corporation Gas Department

By T. R. COOK, M.Inst.Gas E.
Engineer and Manager,
Blackpool Corporation Gas Department

Communication No. 230
(abridged)

The removal of the gas manufacturing plant from the Princess Street Works of the Blackpool Corporation Gas Department to a site on the outskirts of Blackpool is the first step in an important scheme of re-planning which will bring this portion of the town up to date and provide for the enlargement of the Central Station and the development of the necessary railway and sidings accommodation for the holiday trains by which six or seven millions of visitors are annually brought to Blackpool. It was deemed necessary that the main buildings should present a good appearance and even possess considerable architectural merit. It was found possible to design these buildings so that they should raise the prestige of the Gas Undertaking and the Gas Industry in the eyes of the public, and it is claimed that this object has been achieved.

The Princess Street Gas-Works occupies a site within a very short distance of the very centre of the finest seaside promenade in the Country, and the municipality of Blackpool which has always been willing to spend large sums of money to maintain its position and to uphold its amenities, has chafed for many years at this anomaly. It is not difficult indeed, to understand why such an anomaly should exist. This portion of the town is the oldest, built upon the spot where Blackpool began and whence its very name was derived. Consequently it still bears considerable evidence of its somewhat lowly origin. Its amenities are those of a generation which has passed away.

The time is deemed to be ripe for a complete replanning of this important area. Old property is to be pulled down, narrow streets replaced by wide roads, sharp corners by generous curves. The Central Station at which the millions still arrive in Blackpool is to be greatly enlarged while, at the same time, the bottle neck in which the entrance to the station was throttled, where the railway passed through the Gas Works, is to be obviated by setting the station back several blocks and by utilizing the site of the Gas Works for the sidings upon which the holiday trains will be marshalled.

The estimated expenditure on the new Works was £364,000, and if the contract had not been placed before the present emergency arose it is possible that there would be some difficulty in making out a case for the soundness of the scheme from the strictly financial point of view. The lay-out of the existing Works in Princess Street is sound, and a reconstruction and modernization of the carbonizing plant would have effected considerable economies for a capital expenditure much less than that required for the new Works, while there is plenty of unoccupied space upon which additional holder accommodation, together with a modern C.W.G. installation to take peak loads, could have been erected to carry the Gas Undertaking forward for a period of twenty years. This scheme, however, must be looked upon as part of a far more important project, namely, the improvement of what should be the best part of Blackpool.

On the basis of 1937 costs the estimated savings fall somewhat short of the interest and sinking fund charges on the new loan, but in the first place it is considered that these figures may show a different result when they are re-calculated on 1940 and 1941 costs, to look no further ahead, and, in the second place, it is considered that gas consumers may very well be asked to make a small contribution to the cost of so great an improvement in the centre of Blackpool, a contribution which is not likely to exceed the sum which would have been levied on the Gas Undertaking if the system of rate relief had not been abandoned by the Council.

The Author's chief concern was to avoid, as far as possible, over-capitalization. If the amount of money allocated to the Department is sufficient to complete the remaining portion of the scheme, it is estimated that the outstanding debt on the Undertaking will be £540,000, or £360 per mill. cu.ft. of gas sold, which is not an excessive financial burden for an Undertaking of this capacity.

It will be agreed that the whole scheme, including the closing down of the present Gas Works and the building of a completely new and modern Works on a site well out of the town, is just one more instance of the bold and far-sighted policy of those responsible for the local government and development of Blackpool, and their determination to maintain for their millions of visitors a seaside resort which is noted for its modernity and progress.

DEVELOPMENT OF THE GAS UNDERTAKING

The policy of rate relief from the profits of the Gas Undertaking has been consistently followed from the year 1869, and between that date and 1939 no less than £538,767 has been taken from the profits of the Gas Undertaking for the relief of rates. This policy must have restricted the full development of the Undertaking. Indeed, on the appointment of the Author in 1931 he found that the Reserve Fund was at a low ebb. It is of some melancholy interest to note that the Corporation obtained powers, which must be unique in their scope, in one of the oldest of the Blackpool Acts, to apply surplus funds from the Gas Undertaking to any purpose which it may direct. It is therefore not surprising to note that in past years profits from the Gas Undertaking have been applied to purchasing land for other departments, pictures for the Art Galleries, illuminations and decorations, and even to make good deficits on the Electricity Undertaking. This policy is now happily repudiated by the Corporation.

In the year 1869 the total income of the Gas Undertaking was £610, the expenditure £58, the gross profit £552, and, after providing for Loan Charges, the net profit was £38, which was duly handed over for the relief of rates. In 1939 the total income was £248,000 and the gross profit £27,500.

The sales of gas increased from 150 mill. cu.ft. in 1889 to 1,500 mill. cu.ft. in 1939, or ten fold. The number of consumers rose from 4,000 to 44,000 in the same period.

In 1939 gas was supplied to 44,000 consumers, 21,000 of whom used the ordinary meter and 23,000 the prepayment meter, the average per consumer of the two types being 44,148 and 19,518 cu.ft. respectively. A bulk supply of some 20 mill. cu.ft. per annum is also sold to an adjoining authority.

The population of the County Borough of Blackpool is almost entirely residential in character. With the exception of the few light industries, such as biscuit, sweet and toffee making, there is no scope for the sale of gas outside the domestic field. The central heating load has been developed during the past six years and a very useful load has been developed in connexion with fish-frying appliances, which now total 180 installations consuming about 45 mill. cu.ft. of gas per annum; but the Gas Undertaking relies for the bulk of its output on the domestic consumer.

Under this heading is included the supply of gas to widely varied types of appliances in some 5,000 hotels and boarding establishments of all sizes. In the height of the season the demand from these establishments is particularly heavy. The average sale of gas in Lancashire towns with comparable

populations, namely, 125,000, is in the region of from 1,000 to 1,050 mill. cu.ft. per annum, compared with the 1,500 mill. cu.ft. in Blackpool. The difference is undoubtedly due to the influx of the 6½ million people who visit Blackpool every year.

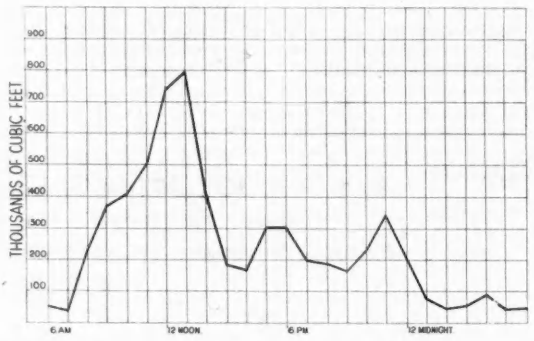


FIGURE 1.—*Hourly Variations in Output at Peak Load.*
(Bank Holiday Monday, August, 1939.)

Figure 1 indicates the hourly output of gas during the period of peak load. The breakfast, luncheon and dinner hours are clearly shown together with that of the nightly "fish and chips" dear to the Lancashire visitor. One of the obvious results of the nature of the load in Blackpool is that repairs to gas making plant, instead of being carried out during the summer, as in most instances, have to be carried out in Blackpool in the winter months.

At the Princess Street Works the total safe gas making plant available was capable of producing approximately 5½ mill. cu.ft. of gas per day against a maximum daily demand of 5 mill. cu.ft. which was rapidly increasing.

EVENTS LEADING TO THE PROPOSED REMOVAL

A report was called for in 1931 by the Council on the desirability or otherwise of moving the entire Works to a new site outside the town. After a thorough examination of all the considerations bearing upon this question a report was submitted, of which the following are the main points·

(i) The existing Works was quite modern in the design of its several parts and both the general working and the financial results would bear comparison with those of any Gas Works in the Country.

(ii) A heavy capital expenditure, amounting to £101,263, had been incurred on the Works in 1926 and 1928 and there were many years of useful life in the plant without undue decline in general technical results.

(iii) The area of the land, 11 acres, was sufficient to enable reconstructions and extensions to be caried forward for a considerable number of years ahead.

(iv) The site had been occupied by the Gas Works since 1869 and the installation of continuous vertical retorts in 1926 and 1928 had, to a very great extent, removed the nuisance justly complained of by the owners and occupiers of property in the vicinity of the Works.

(v) The Reserve Fund of the Gas Undertaking was at such a low ebb that the heavy capital expenditure involved in the construction of a new Works would lead unavoidably to an increase in the cost of gas to the consumer.

(vi) Unless the sale of the land occupied by the Works would yield a sum sufficient to meet this heavy expenditure any such scheme would be financially unsound.

It will be seen that the report was so far against the proposed removal. The following recommendations were, therefore, put forward:

(*a*) To remain on the existing site until the capital commitments on the Works were considerably reduced.

(*b*) To increase the carbonizing plant by the addition of two settings of vertical retorts, capable of carbonizing 64 tons of coal per day, to meet the expansion of demand for a short term and to allow for necessary retort renewals in the existing plant.

(*c*) To carry on with normal repairs and re-settings of retorts as required and for this purpose to create a Retort Renewal Fund.

(*d*) To discontinue the policy of Rate Relief from the Gas Undertaking.

(*e*) To restrict any further capital commitments on the existing Works and to finance any additional plant or alterations out of the Revenue Account.

(*f*) To erect a new gasholder of 3 mill. cu.ft. capacity either on the existing site or on a new site outside the town, preferably the site selected for the proposed new Works.

The reason for the last recommendation was that the storage capacity in the three existing gasholders was inadequate for the peak loads. The maximum daily output had risen to 5 mill. cu.ft., while the effective storage was no more than 3½ mill. cu.ft. Of this capacity, however, that represented by the 1½-mill. column-guided holder was somewhat precarious, because this holder was in urgent need of repair, and, moreover, was of so light a construction as to be unequal to the present-day town's pressure.

This report was considered by the Council and adopted in principle. A long period of discussion ensued, but, pending a decision on the main issue, the question of the location of the new holder, the necessity for which was early admitted, had to be settled, and in 1933 instructions were issued that a site suitable for the proposed new Works was to be selected and the new gasholder built upon it together with the necessary inter-connecting trunk main. At the same time, provision was to be made for new boosting plant at the Princess Street Works and district governor stations.

The site was duly selected and purchased and scheduled for the manufacture and storage of gas and, after the usual enquiry by an Inspector of the Ministry of Health, borrowing powers were granted for the sum of £75,000 for this work.

THE NEW WORKS

The site is admirably situated in relation to main communications by rail and road for the transport of raw materials inward and by-products outward.

Whereas the land was purchased for about £130 per acre, land in the immediate neighbourhood has already been sold at £250 per acre.

The need for additional gasholder accommodation was pressing. It was therefore decided to proceed with this portion of the scheme and to erect immediately the new 3 mill. holder on the new site. An essential feature of the development of the scheme was a trunk main connecting the two Works, the construction of which would be governed by the following considerations:

(i) The main would eventually become the principal feeder for the transference of gas from the new Works to the gasholders at the distribution centre on the Princess Street site.

(ii) The main would always be under either holder or booster pressure.

(iii) The new main should be capable of acting as a feeder for the purpose of reinforcing pressures in certain areas, where necessary, in peak-load periods.

(iv) To complete the scheme it would be necessary to lay a high-pressure main at some future time inter-connecting the two Works or Stations.

It was decided to lay a cast iron main of 30 in. diameter which would be of sufficient capacity to serve the needs of the town for many years to come. The main is constructed of Stanton Pipes, Class "B" with half turned and bored joints. The length is approximately 3 miles and the work of laying it was carried out by direct labour.

Four connexions were made from the new main to four Reynolds' district governors, one 12 in., one 9 in., and two 6 in., at points where pressure needed reinforcement during hours of peak load. The governors, which were manufactured by the Bryan Donkin Company, Limited, are fitted with a clock-controlled air pressure governing system and are housed in suitable kiosks above ground with convenient access. The pressure control system is arranged to give three district pressures at predetermined times which can be varied as required.

For the purpose of delivering gas from the Princess Street Works to the new holder, two two-stage boosters were installed. These machines have each a capacity of ¾ mill. cu.ft. per hr., against a pressure of 30 in. w.g., one electrically

driven by a variable speed motor of 145 h.p. and the other by a steam turbine of equal power.

In determining the capacity of the boosters to be installed due regard was given to the probability that these machines would eventually be transferred to the new Works.

The cost of the scheme up to this stage was as follows:

Purchase of new site, 100 acres	£13,300
Gasholder and tank	33,997
Excavations and foundations	2,500
Boosters	1,735
Booster house, valves and connexions	1,260
30 in. trunk main, 4,604 yards	11,834
Laying main—temporary reinstatement trenches	6,996
Complete reinstatement trenches	1,949
District governors, kiosks and controls	696
	£74,267

In order to cope with the increasing demand for gas between the years 1935 and 1937 it was also necessary to install immediately certain ancillary plant, and during this period a complete section of condensing, and wet and dry purification plant was put down on the Princess Street site, capable of dealing with 3 mill. cu.ft. of gas per day.

Certain other plant of minor importance was also installed during this period. It comprised a concentrated ammonia plant capable of dealing with 25,000 gal. of liquor per day, benzole-washing plant capable of dealing with 5½ mill. cu.ft. of gas per day (extracting 1¼ gal. of benzole per ton of coal carbonized), an electric generating set of 125 kW capacity and a new air blower for the C.W.G. plant. The total cost of this work was about £13,000, this sum being taken out of the Revenue Account. In the installation of all these items it was borne in mind that they should be capable of easy transference to the new site in due course.

General Arrangement of the New Works

The New Works Scheme was given its final impetus by the negotiations which were opened in 1937 with the London Midland and Scottish Railway Company in connexion with an important scheme for the improvement of the central portion of Blackpool which involves the setting back of the Central Station, to be re-built on a new site, and the transference of the site of the East Works to the Railway Company for the construction of sidings. This interesting project, the total cost of which is estimated to be in the region of £3,000,000, has already been embodied in an Act of Parliament. It will, of course, be held up during the War. But in any case, as five years would be required for the completion of the scheme, it was decided to carry out the removal of the Gas Works in two stages.

In the first stage a complete new Gas Works would be built on the site with carbonizing and all ancillary plant of sufficient capacity to cover the maximum daily demand which might be anticipated during the next few years. In the second stage a new 3-mill. holder and C.W.G. plant would be erected and certain useful plant would be moved from the Princess Street Works before finally transferring the existing site.

The general arrangement of the new Works is based upon the following data and requirements:

(i) The maximum daily demand during 1939 was estimated to be about 6 mill. cu.ft. It was therefore decided to install carbonizing plant of a daily capacity of 7 mill. cu.ft. with provision for extension to 8 mill. in the near future.

(ii) Room was to be allocated for the installation of C.W.G. plant in the general lay-out.

(iii) Water-cooled condensers capable of dealing with 8 mill. cu.ft. of gas per day.

(iv) Tar and ammonia washing plants in two distinct sections each of 4 mill. cu.ft. daily capacity or a total of 8 mill. It was decided to divide the gas stream in this plant into two for ease of cleaning and to enable one unit only to be used during periods of minimum demand.

(v) Dry purification plant of a capacity of 7 mill. cu.ft. of gas per day.

(vi) On the completion of the Works it was decided to transfer the secondary condensers and a complete section of wet and dry purification plant from the existing site. This can either be used for the purification of coal gas or as a distinct C.W.G. unit. Two exhausters, each capable of handling 125,000 cu.ft. per hr., will also be transferred.

(vii) The concentrated ammonia plant and the benzole plants will be transferred from the old to the new site as required.

(viii) Ample storage accommodation for tar and liquor below ground.

It is anticipated that the gas making plant will be of sufficient capacity to carry the load until 1945, assuming normal development, but the question of the installation of C.W.G. plant in the near future will be dependent upon the development of the coal and coke markets.

Description of Plant

Carbonizing Plant

This is naturally the most important item in the design of any Gas Works. The Blackpool Gas Department has always been enterprising in the selection of carbonizing plant. Horizontal retorts with machinery were superseded by inclined retorts as early as 1900, and in 1911 the Blackpool Gas Undertaking was one of the first in this Country to adopt the Glover-West system of continuous vertical retorts. The original installation was doubled in 1914, bringing the capacity to 1½ mill. cu.ft. per day. In 1926 a further bench with a daily capacity of 3¾ mill. was the first large installation of the 40-in. Glover-West retorts to be brought into operation.

For the new Works the retort selected is 50 in. on the major axis at the top, 25 ft. in length, of the standard elliptical cross-section with the helical coke extractor at the base. The retort house is laid out in two benches, one containing 5 beds each of 8 retorts and the other 4 beds with room within the house for the fifth bed to be added with the minimum delay and expenditure. Each bench is divided into two sections by a division wall of additional thickness for convenience in bringing sections of the plant in and out of operation as required by fluctuating demands. The capacity of the plant is a net 7 mill.cu.ft. of gas per day; when extended it will be 8 mill. cu.ft.

Very great care has been taken in the design of the settings to allow for the expansion of the refractories, and the retort-bench bracing has been carefully studied with a view to providing for adjustment when renewals are made. The heating of the retorts is effected by gas generated in two batteries of producers, which are built external to the retort benches, and these producers, five to one bench and four to the other, are fitted with pressure equipment and designed for the use of screened breeze.

Coal Handling

Coal is brought to the installation in wagons on a line of rails running parallel to the retort house and at a distance of about 103 ft. to the south of it.

An important feature of the design is a double line of gravity-bucket conveyor of the lipped-bucket type built within a steel structure which is independent of the retort benches and, therefore, not liable to be distorted by any movements of the latter. These conveyors rise to the full height of the retort house and are employed for receiving and elevating both coal and coke to a level above the coal storage bunkers of the retort benches. Coal, thus received by either of these conveyors, is passed to either of two shuttle band conveyors by means of which it is distributed over the 60 hr. storage bunkers above the retort benches.

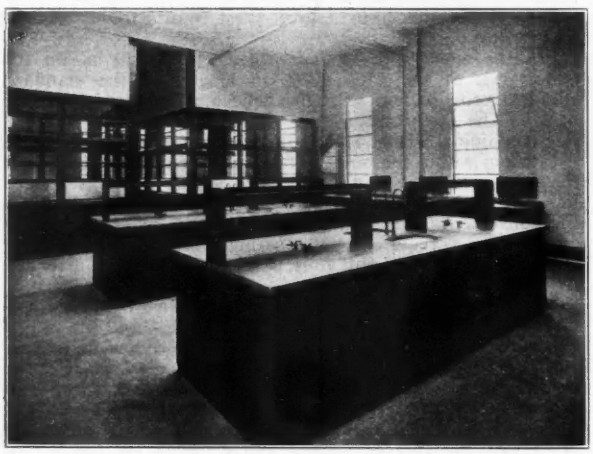
Coke is also received by either of the same lipped-bucket conveyors from one or other of the duplicate band conveyors placed in troughs below the retort benches, elevated and passed either to a producer and retort-feed hopper immediately below them and built into the same structure, or to a band conveyor which passes along the top of the west retort bench and thence to an inclined band conveyor which takes it to the coke-grading plant.

Coke as discharged from the retorts, or breeze returned from the coke-grading plant, is elevated by the lipped-bucket conveyors and the coke is dumped direct into a central compartment for feed over a vibrating debreezing screen to railway wagons running on a line parallel and adjacent to the south side of the retort house, while the overflow of coke from the surcharge of the compartment flows to two smaller compartments, one on each side, for supplying coke to fill the retorts when they have been out of operation for any cause. The breeze returned from the grading plant is discharged over a vibrating de-dusting screen into a fourth compartment terminating in a double outlet for feed to producer-filling skips or to the firing floor of the solid-fuel boiler house while the fines are collected in the fifth compartment for feed to the producers. The producer-filling skips are electrically propelled on an overhead monorail and the contents are automatically weighed and recorded.

Coke from the retort house is discharged from the inclined band conveyor already referred to into a receiving shoot, which directs it either to a coke cutter or direct to one of two primary screens which form the first stage of two complete duplicate sets of coke grading plant, each of a capacity of 30 tons per hr. The primary screens take off coke over 1½ in. mesh. This large coke is either fed direct into the bunker by way of a spiral shoot to prevent breakage or by a 24 in. band conveyor to a second spiral shoot towards the west end of the bunker.

Coke through 1½ in. is fed to another 24 in. band, which passes it to a secondary screen with two decks, the upper of ¾ in. mesh and the lower of ⅜ in. mesh. Coke through 1½ in. and over ¾ in. is directed to a spiral shoot for lowering it gently into one compartment of the bunker, that through ¾ in. and over ⅜ in. is directed to another compartment, while the fines are directed to still another compartment of the bunker. It is to be understood that the whole of this apparatus is completely duplicated.

The coke bunker has a total capacity of 1,000 tons of the several grades of coke. Outlets and shoots are provided



Laboratories.

for feeding railway wagons, road vehicles and bagging apparatus, while the breeze and dust can be returned to the retort house by means of an 18 in. band conveyor which passes below the full length of the bunker and discharges into the band conveyors below the retort bench and so to the central lipped-bucket conveyors.

All grades of coke can be fed to either railway wagons or road vehicles, but bagging apparatus is provided for only the two larger grades.

Steam and Electricity Supply

Economy of fuel is provided for by the installation of waste-heat boilers raising steam from the residual heat of the products of combustion as they leave the settings, and by solid-fuel boilers designed for the use of breeze. Three Spencer-Bonecourt waste-heat boilers of the usual horizontal induced-draught, fire-tube type, are installed, each capable of dealing with the gases from five settings, and the flues are so arranged that the third boiler is a standby to either of the other two. In addition, provision is made for augmentation by means of which producer gas can be passed direct to the waste-gas flues when some of the settings are out of operation.

The boilers are housed in a building annexed to the north side of the retort house. Two solid-fuel boilers (with provision for a third), of the so-called "Economic" or "Dry-Back" type, are placed on the ground floor and the three waste-heat boilers on a floor immediately above.

After very careful consideration it was decided to install electricity generating plant and to drive by electricity the whole of the coal and coke-handling plant, as well as the many pumps and other portions of the ancillary plant, with standby supply from the Electricity Department. Not only is the Gas Works thus free from risk of breakdown in the town supply, but full advantage can be taken of power generated by steam raised by surplus heat from the settings or the combustion of low-grade fuel. The maximum anticipated requirement was 149 kW. It was therefore decided to install three steam-driven sets, each of 150 kW capacity, and as a considerable quantity of process steam at low pressures would be required, particularly in the retort house, engines of the back pressure, or pass-out, type were clearly indicated.

The dynamos are actuated by Belliss and Morcom two-crank, two-cylinder, vertical, combined back-pressure engines running at 500 r.p.m. and of the standard design in every respect except that the piston and valve rods are "fescolized" (or coated with chromium) over those portions which pass through the glands to reduce erosion at these points. The engines are direct-coupled to G.E.C. direct-current dynamos capable of developing continuously 150 kW at 440 V and of sustaining a 10 per cent overload for 2 hr.

The town supply is alternating current and it was necessary to install a rectifier and transformer. This apparatus is of the mercury arc type supplied by the Hewittic Electric Company, Limited. It is of 400 kW capacity.

Condensers

These are constructed in two sections each capable of cooling 4 mill. cu.ft. of gas per day, measured at a normal temperature and pressure, from 160° F. to 65° F., and each with a tube cooling surface of 10,000 sq.ft.

The tube condensers are worked and by-passed by means of the five 30 in. diameter Bearscot-Andrews double-faced valves, and the whole apparatus has been built by R. and J. Dempster, Limited, with the latest improvements.

Two exhausters are installed, each capable of handling 7 mill. cu.ft. of gas per day, creating a vacuum of 6 in. w.g. and delivering against a pressure of 40 in. w.g. They are of the Holmes Connersville positive displacement type, 16 in. by 39 in., running at a speed of 395 r.p.m., absorbing 43 b.h.p., driven by Ashworth and Parker two-crank, compound, totally-enclosed, forced-lubricated steam engines.

Washing Apparatus

This consists of two Holmes Multifilm static washers, each capable of dealing with 4 mill. cu.ft. per day each in four units. The gas connexions comprise one 36 in. and four 24 in. diameter Holmes double-faced Western valves and the necessary 36 in. diameter by-pass main and 24 in. diameter branch mains, all in riveted mild-steel plates ¼ in. thick to form a combined by-pass to each washer. The washing medium is stripped liquor or soft water.

The two Livesey washers are also by W. C. Holmes and Company, Limited, 15 ft. by 9 ft. by 3 ft. 6 in. deep inside, each with a capacity of 4 mill. cu.ft. of gas per day.

The two Pelouze and Audouin tar extractors are of the Holmes columnless type, each with a capacity of 4 mill. cu.ft. of gas per day.

The Holmes Dri-Gas Plant is capable of dealing with 8 mill. cu.ft. of gas per day. The washer is of the Holmes Multifilm Static Brush type.

Dry Purification Installation

This was built by Clapham Brothers, and consists of six dry-lute boxes built in two sets of three with a space of 14 ft. between which accommodates the 30 in. diameter operating valves and connexions. A revivifying floor 138 ft. in length by 38 ft. in width is arranged alongside each set of three boxes.

Working in either forward or backward rotation is effected by 30 in. double-disk valves and connexions. All six boxes are arranged to work in series and any one or more consecutive boxes can be isolated, the flow of gas being downward through the oxide. The valve disks make metal-to-metal contact with their seatings and are provided with rotating gear so that the disks can be rotated in contact with their seatings, eliminating the deposit of foreign matter. The spindles of all valves are in a vertical position with convenient working access from the purifier decks and connecting open steel grid platforms.

Pressure readings are centralized in two batteries of double column gauges housed in asbestos-lined metal cabinets. Thermometers, test taps and steaming arrangements are provided for each purifier. The gas inlet temperature to the purifiers is controlled by a Triumph gas heater capable of raising the temperature of the gas stream by 80° F. A device is also fitted for maintaining the correct humidity by admission of steam to the gas stream. The heater can be by-passed for repairs.

The station meter is of the Connersville type and is capable

of passing 8 mill. cu.ft. of gas per day, and is complete with the usual P.V.T. recorder.

Gasholder

This was erected in 1933/4 and is built with four lifts spirally-guided in a steel tank. The main details of the holder and tank follow the standard practice of R. and J. Dempster, Limited, in the design of a heavy type of gasholder, except for the carriages, which are of the four-roller type. The inlet and outlet pipes are diametrically opposed and provided with safety seals. All plates below ¼ in. in thickness are of genuine puddled iron and all above that thickness are of Siemens-Martin mild steel, all of British manufacture.

The pressure thrown by the gasholder when the main lift is rising is equivalent to 6 in. w.g., and when all four lifts are inflated it is equivalent to 14½ in. w.g. These pressures are

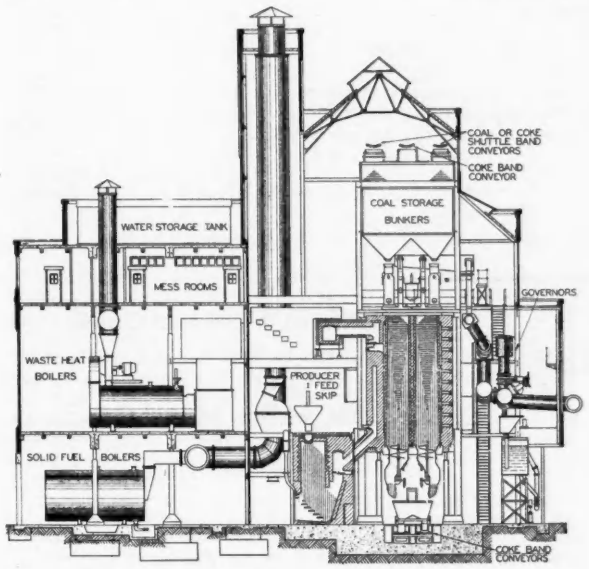


FIGURE 2.—*Retort House—General Cross-Section.*

obtained by the self-weight of the holder lifts, no loading weights being used. The gasholder and tank are fully equipped with anti-freezing arrangements, injectors being fitted to each cup as well as to the tank. Steam is supplied from a vertical tubular boiler installed for the purpose.

The holder is fitted with the Widlake Recorder System, the panel being fixed in the booster house at the Princess Street Works, where the contents of the holder can be read at all times by the attendant on duty there.

The booster is of the 40 in. three-stage type by Keith Blackman, Limited, driven by a Greenwood and Batley electric motor, and is installed to transmit gas to the gasholders of the Princess Street Works and the medium-pressure mains in the district system. The capacity of the booster has been fixed with a view to possible requirements for some years to come. It is capable of dealing with 1 mill. cu.ft. of gas per hr. against a differential of 63 in. w.g. between the inlet and outlet when running at 2,440 r.p.m., absorbing 256 h.p.

The coupling between the motor and the booster is manufactured by Wellman Bibby Company, Limited.

AMENITIES IN THE MODERN GAS WORKS

As the site of the new Works would be bounded by a new by-pass road along which many visitors would come to Blackpool, it was decided to build a retort house on pleasing architectural lines in the foreground of the site and to set out the ancillary plant and other buildings so that as far as possible the retort house would screen off the purifiers and other plant for the working up of residuals which are not so conveniently concealed.

The retort house presents a frontage to the north of about 245 ft., the main roof rising 88 ft. to the apex above yard level. It is disposed in two wings about a central tower rising 96 ft. above ground level which conceals the chimneys and which is supported by the boiler house, engine house and workmen's rooms, while at the extremity of each wing two subsidiary towers contain the lifts giving access to the working platforms of the carbonizing plant. The coke grading and storing plant is placed at the west end of the retort-house building. With the brick filling of the panels and the housing over the screening plant above the bunkers it forms a structure in keeping with the retort house.

The whole is built in straight pilasters between the ground and the strong horizontal line of the roof, in the manner of much modern architecture. Modern carbonizing plant is so free from smoke and dust that it can be thus enclosed without detriment to its operating efficiency. The building is constructed in steel framing filled in and covered on the outside with the well-known Accrington "Nori" brick, which has a highly finished surface readily washed and kept clean by the rain. The horizontal lines of the roofs are emphasized by courses of white artificial stone.

Such portions of the ancillary plant as can be covered are housed in buildings of uniform design with steel-framed structures faced with Accrington "Nori" bricks set in cement mortar and surmounted by artificial stone water tabling. Flat roofs are used in all cases to facilitate the application of A.R.P. measures. The roof covering adopted is "Turnall" reinforced asbestos slabs 6 ft. in length by 2 ft. 6 in. in width supported on secondary roof joists 6 ft. pitch, and covered with four layers of bitumen compound and three layers of special roofing felt, laid alternately, and the edges finished with lead flashing into the side walls. All roofs are designed for an additional superimposed load of 1½ cwt. per sq.ft. over and above the usual allowance for snow load, etc.

Placed centrally behind the retort house is a building of comparable proportions to accommodate the exhausters, the future C.W.G. plant, fitters' and joiners' shops.

The laboratory and stores are accommodated in one building, 29 ft. 3 in. wide by 14 ft. high to the inside of the main roof girders, the laboratory section being 60 ft. 9 in. long and the stores 70 ft. 9 in. The laboratory comprises a general laboratory (Figure 3), from which access is provided to the calorimeter room, the chief chemist's office, the balance room, the coal and coke testing room, and the tar and benzole laboratory. Heating is provided by a Lumby Solar gas-fired boiler placed in a cellar under one portion of the building.

Other amenities which nowadays are rightly considered an essential part of Gas Works design include generous provision for the comfort and cleanliness of the workmen and particularly of the personnel of the retort house. Adjoining the retort house, with easy access to the working platforms and arranged on a floor above the engine and boiler houses, ample space was found for the construction of rest rooms, lockers, washing places and dining rooms for stokers and shift engineers.

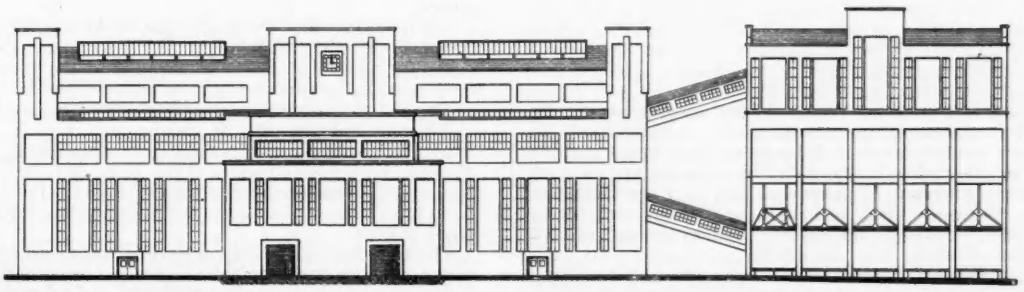


FIGURE 3.—*Elevation of Retort House Buildings, from the North.*

APPENDIX

SCHEDULE OF COSTS OF NEW GAS WORKS

Arterial road and drainage	£8,400
Works roads and drainage	7,740
Works gates	250
Boundary wall and fence	1,500
Road weighbridge	469
London Midland and Scottish Railway sidings	8,076
Works railway sidings	16,996
Railway weighbridge	340
Railway weighbridge house	150
Carbonizing plant and coke plant	199,075
Water-cooled condensers	7,903
Connersville exhausters	3,775
Livesey washers	2,252
Pelouze and Audouin tar extractors	1,999
Static washers	4,738
Purifiers and sheds	29,787
Gas dehydration plant	4,062
Station meter	1,635
Tar and liquor wells	5,793
Tar and liquor separators	325
Pump house and pumps on wells	315
Tar loading tank	270
Other works buildings	21,476
Generating sets	5,364
Steam mains, etc., for above	1,500
Removal of concentrated ammonia plant	700
Concentrated ammonia storage tanks	440
Gas mains and valves	8,614
Tar and liquor mains	814
Water mains and hydrants	1,900
Steam mains	1,750
Lighting of buildings	2,000
Heating of stores and laboratory	250
Removal of water-cooling tower	500
Four oxide conveyors	720
Town supply and feeder panel	442
Transformer and rectifier	1,495
House for above	385
Electric booster	2,650
Transfer of existing booster	250
Connexions for above	500
Works locomotive	1,590
Bore-hole	2,087
Bore-hole pump	489
Bore-hole pump house	300
Removal of ramp	515
Proposed electrostatic de-tarrer	1,750
Removal of existing water-cooled condensers	1,500
Removal of existing benzole plant	850
	£366,681

Observations on the Economics of By-Products Recovery in Gas-Works

Communication No. 231 (abridged)

By

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The by-product plant engineer is in practice concerned with many matters other than the actual recovery of residuals, or even the removal of impurities, from crude gas. The machinery of gas handling and so forth comes within the same province, and improvements therein may have their effect on the general economics of gas making.

Prior to the introduction of continuous vertical retorts very little change had taken place for a long period in plant design. Tar was more or less uniform in quality and, except on the larger Works, was disposed of to the distillers for pitch making. There was no difficulty in producing a liquor of "reasonable strength", generally accepted as 10 oz., and a substantial return was obtained from it as ammonium sulphate, selling at as much as £15 per ton either in working it up at the Gas Works or by sale to chemical manufacturers. At the average Works, coke breeze was regarded as almost a waste product and consequently there was no shortage of fuel for steam raising, and the cost of the latter was regarded as almost negligible.

To put the monetary aspect in the form of a brief statement means citing only one case out of many possible, but it is somewhat instructive even in an elementary form.

TABLE 1.—*Financial Aspect of By-Products Recovery*

1 ton coal at 25s. ...	300d.	0·5 ton coke at 25s. ...	150d.
		14 gal. tar at 2d. ...	28
		7 lb. ammonia, net ...	3
		3 gal. benzole, net ...	15
		Total ...	196d.

There is here a credit of 196d., which if eliminated, say, by reason of modification in methods of gas making, must be replaced by gas revenue. If, in general, these prices are not realized for the residuals, the deficit is reflected in increased cost of gas. Allowing 75 therms per ton as a representative case, the apparent effect is to reduce the 4d. per therm required to buy coal by 2·6d., leaving 1·4d. as net cost of coal per therm.

The coke revenue, of course, can be partly translated into gas revenue, and this takes place when gas is steamed to lower calorific values, or if water gas is made. If the value of the coke is 1d. per therm it must be gasified at an efficiency approaching 70 per cent and sold at the same price per therm as the coal gas if the coke is to be eliminated without loss.

There are, of course, many other considerations to be taken into account, such as seasonal load changes before a satisfactory analysis can be set out, but the statement in Table I is intended to illustrate the order of values.

The transformation does not, in fact, create as much gas revenue as it absorbs coke value, so that for most Undertakings an economical limit is found to exist, reflected in the choice of calorific value maintained.

Tar at 2d. per gal. is equivalent to 1·3d. per therm in fuel value and crude benzole has an actual sale price of about 8d. per therm, once the extraction has been made.

REMOVAL OF IMPURITIES

CONDENSATION AND HEAT ECONOMY

The provision of satisfactory cooling for crude gas has been found to be a problem with many aspects. The design of the cooling apparatus has gone through many changes, and the principles underlying design may now be said to be well recognized. Gas cooling formerly did not present any difficulties. The provision of both air- and water-cooled condensers was common practice. The introduction of steaming in excess of the requirements for cooling the coke before discharge in operating vertical retorts introduced many new problems and the primary one was increased condensing power.

Apart from the increased gas volume from any one carbonizing unit, which might be 50 to 70 per cent, a considerable "slip" of steam occurred, and the total heat load on a condensing system might increase fourfold.

This will be appreciated by reference to Figure 1.[1]

Not only did this call for greater contact surface but for a more efficient form of condenser providing higher velocity of travel of both gas and water at the point of heat transference. Various types of tubular condensers of vertical and horizontal form have been evolved to satisfy more or less efficiently these requirements.

The question of cost of condensing water, except in Works where supplies are obtainable for the cost of pumping, has become a much more serious problem, and schemes have been successfully introduced in which the cooling water is recirculated over a cooling tower. A percentage calculated to

maintain a sufficiently low temperature at the condenser outlet is supplied as "make-up", and as a means of permitting a certain proportion to be withdrawn from circulation. The water withdrawn may be used for boiler feed water or other purposes, and may be a controlled amount, taken from the hot end of the condenser to obtain a maximum temperature.[2 3]

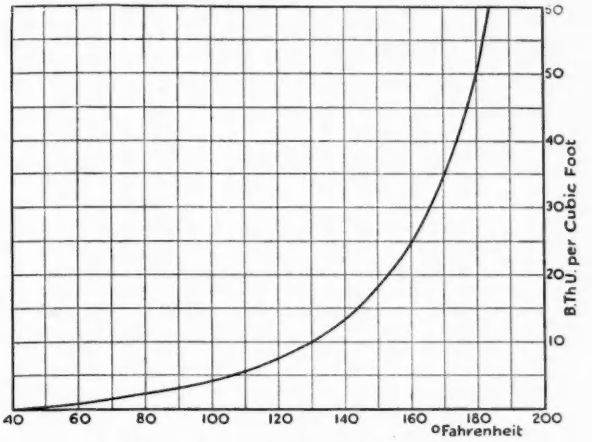


FIGURE 1.—*Heat Content of Gas at Various Temperatures.*

Thermostatic controls are frequently used to regulate the cooling system automatically and to maintain even gas temperatures with a minimum water consumption.

The remaining problems are connected with the cost of supplying a satisfactory cooling water, and with the choice of construction materials where a satisfactory supply is difficult to obtain. The obvious solution of air-cooled water in a closed circuit can hardly be said to be applicable without some reservations in all cases. In Appendix 1 will be found a description of working results on such a system, with its economic justification.

The very considerable areas of cooling surfaces involved in the condensing of large volumes of saturated gas preclude for practical purposes all materials of construction other than iron. Much of the cost of gas cooling, apart from the delivery of water, is represented by the capital cost of the units, and afterwards by their maintenance. Where the water is fresh, or has been air-cooled, corrosion of the iron occurs from dissolved oxygen. This form of attack has been met by working with alloyed irons, with only partial success, by using heat-treated mild steel and wrought iron, on which work is still continuing, and by treating the water itself. The latter method is practicable in closed circuits only, owing to cost, but the results appear to be promising.[4] Where highly corrosive waters are found, a general solution is to adopt cast iron construction throughout. This construction may be relatively expensive, but the maintenance costs are very low indeed.

There are a number of cases, of course, where the main trouble in cooling arises from water which carries suspended matter, or which deposits scale from solution. Where these waters are of high alkalinity, the corrosion is often found to be at lower rates than from clean water. Condensers with vertical tubes, open at the top, are convenient in these cases, as they can be cleaned frequently without interruption in operation. A few cases occur of deposition of vegetable matter from industrial waters, and a remedy may be found in the addition of chlorine in controlled amounts.

For almost any kind of water supply, the design of washer cooler popular in the United States can be applied.[5] In this device, the actual cooling of the gas takes place in a tower scrubber by contact of the gas with cooled gas liquor, the re-cooling of the latter being performed in closed cooling racks of the type used for cooling debenzolized oil, with the water flowing over the outside.

Tar Extraction

It is not possible to separate altogether the cooling of the gas from the recovery of tar and ammonia. Simple cooling will bring down all but a trace of the tar vapours, and the high specific gravity of tar gives the means of separating it from the condensed liquor. There is, however, a range of lighter oils, most noticeably in the case of gas from heavily steamed vertical retorts, which are deposited in the later stages of cooling, and which may be lighter than the liquor, so that separation is delayed or may be hardly possible.

A similar result appears where the gas is treated hot for tar extraction by an electrical precipitator. Here the heavy constituents have been removed, and practically all the later oil condensate is lighter than water. These oils, and the liquor accompanying them, are usually richer in tar acids than the normal run of condensates, and the condition has been found of more than technical interest.[6] This persistence of light condensates after the removal of the main tar fraction has its parallel in the case of horizontal retort gas, where solid naphthalene may appear in gas already cooled, and if precipitation is carried out on the hot gas the quantity of naphthalene which appears is increased.

The use of electrical precipitation methods for the removal of the last traces of tar is steadily gaining ground, and is almost standard practice in the coke oven carbonizing industry.

Improved technique has reduced the cost of such installations in recent years, and in the case of medium and large works it may be said that the cost of installation is comparable with that of mechanical tar extractors in such number in series as to give similar efficiency, and the power cost for running will generally be less.

Tar-free gas is obviously beneficial to ammonia washers and also to purification plant. It has been pointed out, however,[7] that the reported tar content of spent oxide is not affected directly in proportion to the reduced tar content of the gas, and that much of the material reported as tar in oxide is derived from gas constituents brought down by other means, in the purifiers. A similar observation has been made that the complete absence of tar fog from the gas does not solve finally the problem of sludge formation in benzole wash oils; at any rate, in coke oven installations, where the washing is carried out on crude gas.[8]

Nevertheless, the benefits of clean gas to washing and purification plant are undoubted, and are best realized by the complete removal of tar obtained in electrical precipitation plant.

Ammonia Recovery

The status of recovery of ammonia is reverting to that of the elimination of an impurity, and the realization of positive revenue from dilute ammonia liquors is increasingly difficult, because of the recent reduced values of ammonia products when put into marketable form. A further matter to be noted is that liquors from steamed vertical retorts contain relatively greater quantities of toxic materials, which are not eliminated in the distillation of the liquor before its discharge as a waste product.

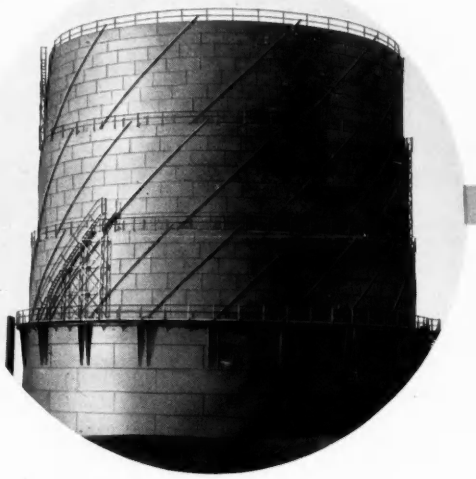
In view of these changes it is not surprising that in many Works the complete rejection of the ammoniacal liquor as made would be counted as the most economical method of disposal, if penalties could be avoided. Such a state of affairs is a challenge to chemical engineers, either to reduce the difficulties of collection of the ammonia or to devise means for its more economical recovery and purification.

The fixation of ammonia for its better storage, transport and utilization is still nearly always by conversion to sulphate, either at producer's works or at central purchasing stations. There is, of course, a second connexion with sulphuric acid, in that most spent oxide from purifiers realizes its value by sale for acid making. This reciprocal trade is adversely affected by any ammonia which does not find its way into combination with "oxide-produced" acid, and it is probable that, at any rate in times of normal production, this trend will continue. If ammonia cannot be disposed of in normal trade, a slight depreciation of the oxide market will not be likely to bring sulphate manufacture back to the Gas Works.

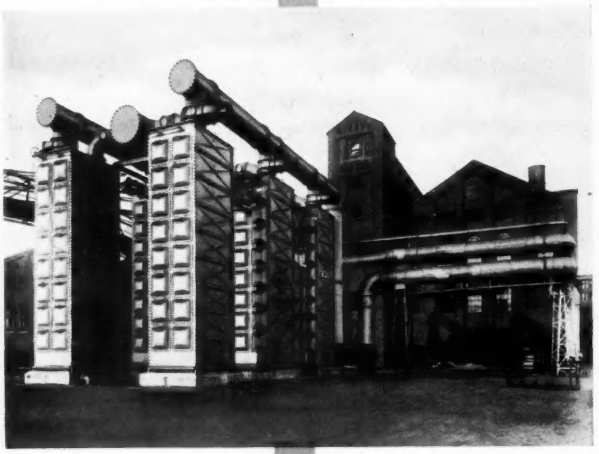
Methods have been described for the destruction of ammonia in gas retorts.[9] A large-scale experiment on the basis of a British Patent[10] has been carried out for its conversion chiefly to sulphate, by the exposure of ammonia solutions to flue gases containing sulphur dioxide. This experiment also demonstrated the extent to which the actual bulk of weak liquor could be evaporated into the chimney gases by waste heat. Briefly, the results are that in the majority of Works, any reasonable make of liquor could be disposed of and the product could be either substantially sulphate of ammonia, a solid mixture of salts of ammonia, sulphate predominating, or a highly concentrated solution of these salts. The fertilizer value of the latter compounds was not noticeably inferior to that of an equivalent weight of ammonia in sulphate form. The process required a very complete oxidation of the first compounds formed, chiefly sulphite, to avoid loss of ammonia from the heated solution. This oxidation was readily obtained when the source of ammonia was relatively pure, e.g., crude concentrated liquor, but it was interfered with when using crude liquor only, by the organic impurities such as phenols, which acted inhibitively.

WHESSOE'S CONTRIBUTION

SPIRAL GUIDED GASHOLDERS



CONDENSERS



Whessoe may fairly claim that their name is a household word in the world of Gas, and that their range of products has made no small contribution to the high standard of efficiency which prevails in the industry.

A recapitulation of the Whessoe range makes impressive reading. There are:

TELESCOPIC GASHOLDERS, Spiral and Column guided, in sizes from a few thousand cu.ft. up to 6,000,000 cu.ft. In addition to riveted holders, Whessoe are building gasholders of all welded construction.

PRESSURE GASHOLDERS. Cylindrical and spherical types of holders for storing gas at pressures up to 50 lbs. per sq. in. or more. The Whessoe Company's prominent part in developing this method of storage is proved by the actual number of jobs built.

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In another series of experiments, on the same lines, on the basis of a further British Patent,[11] the exchange of sulphuric acid was carried out by lime. Calcium sulphate was produced by the reaction of chalk and flue gases completed under oxidizing conditions, and the calcium sulphate was submitted to double decomposition in an ammonia washer, with ammonium carbonate in the form of the ammonia and CO_2 from the gas. This process is free from the tendency to make compounds other than sulphate, but is not directly applicable to liquors. Ammonia has to be distilled to make it available.

The employment of these processes is simply a question of cost and revenue as against current methods of fixation, and one can imagine circumstances arising which would justify their development into gas works operations. An obstacle which might require to be overcome would be the appearance of nitrogenous fertilizer under possibly an unfamiliar guise. This latter point arises also in connexion with the process sponsored by The Institution of Gas Engineers, for the conversion of all or part of the ammonia into bicarbonate.[12] While this method does not appear to have been adopted commercially, it is one which, as in the two cases previously cited, might receive a strong stimulus under conditions of restriction of acid supplies.

The process of crude liquor concentration, whilst having local application where a centralized purchaser exists, and where the immediate disposal of the effluent is permissible, does not give a complete solution to all Undertakings. The more refined process of making industrially pure ammonia has an even more restricted application. It offers a new field in one respect, however, in that ammonia in this form is convertible to nitric acid, a possible alternative fixation of nitrogen which has not had much attention from by-product ammonia producers.

There is no apparent limit to the alternatives which may be proposed for the disposal of gas works ammonia. The position has for many years been simply that costs of successive processes have been too high to fit in with the diminishing perspective of market prices, at any rate for the small and medium producer.

Gas Washing

Practices in ammonia recovery have not, however, been awaiting a regeneration in price of the product. The question of the washing of gases has had a good deal of theoretical study, much of it based on the removal of ammonia from crude coal gas in indirect recovery practice.[13]

During the last ten years the familiar rotary type of ammonia washer has been, in most new installations, superseded by the static type. In its most recent form, the latter gives more complete freedom to design for a given duty, because it will permit simultaneously of arranging for a given resistance to gas flow, a wider range of duties, and almost invariably a lower capital cost. The rotary washer set a high standard in respect of reliability, and the success of the new designs shows that this standard is being maintained.

The static washer is, moreover, able to undertake certain duties which were, for practical purposes, outside the range of the rotary machine, and could only be undertaken in the alternative by large and expensive tower scrubber installations. Single units for ammonia and benzole scrubbing have been supplied for daily throughputs of over 1 mill. cu.ft. hourly, and for gas dehydration and naphthalene removal even higher.

A more recent problem, that of handling economically the very high oil throughputs required for the extraction of organic sulphur compounds, particularly for fairly large gas streams, has been solved by a design of washer which passes the oil through the washer strictly in counter-current, i.e., once only over each effect. The standard type of washer relies for its high performance on a local circulation several times the liquid throughput, but, for the case of de-sulphurization, power economy is of supreme importance. Whether this design has possibilities beyond its present particular application is a matter for further enquiry. The object of the new design is actually to convert the sectional washer to a continuous series of counter-current effects, equivalent to a tower scrubber of high efficiency.

The economy of ammonia recovery has demanded at all times a performance from ammonia washers which would be represented by the use of the minimum quantity of washing water, and there are many cases where circumstances dictate that a practicable minimum does not give a satisfactory concentration. It has, therefore, been proposed to employ, instead of fresh water, a stripped residual liquor, whether from an ammonia still making sulphate or concentrated liquor, or from a still particularly designed as an auxiliary to the washing plant.[14]

In another case, designated the Horseferry Process,[15] the weak liquor for this duty was obtained from the hot condensate leaving the retort house. Apart from a minor problem created by the insufficient stripping of such liquor, usually solved by saturating it with CO_2 before use in the washing process, the effect is the same, that is, to obtain the extraction of all ammonia with the water of condensation. An enrichment effect of some 20 per cent in the liquors made can be expected in the average case. A secondary advantage is that the water, as a washing medium, is in this form free from any mineral salts in solution, so that scaling of the washer fillings by the formation of chalk or similar compounds is avoided. This is just as important in the static as in the rotary washer.

During the last few years it has been observed that the designers of coke ovens have in many cases departed from the previously stereotyped semi-direct recovery of ammonia in favour of indirect recovery through the agency of washers. The recovery of ammonia as liquor offers, of course, the possibility of alternative production either of sulphate or of other ammonia products. Also, even where a roughly constant rate of gas make is observed, the capital cost of an indirect recovery plant compares favourably with the semi-direct plant.

Effluents

A standing problem for the gas engineer, which has already been mentioned, is the disposal of effluent ammonia liquor from the ammonia distillation process.

On the average, Gas Works will have for disposal, in the form of polluted water, some 20 per cent of the weight of coal carbonized. In current practice this material is discharged with the minimum treatment which will make it acceptable to authorities responsible for drainage and water-courses.

The number of cases where complete rejection without treatment of any kind can be practised is relatively small. Distillation by steam removes ammonia, H_2S and some minor impurities, but the form of effluent liquor thus produced cannot be said to be a measurable improvement. The most objectionable constituents remain, in the form of phenolic and other organic bodies in solution, and certain acid radicles which have toxic and reducing properties.

The maximum reduction in toxic impurities that has been worked for on the full scale amounts to about 75 per cent. This has been accomplished in the Manchester and Glasgow Works by the benzole extraction process.[16] It has to be recognized that for financial loss to be avoided, the phenolic acids extracted must be sold at a certain average price, and that this may be a price not always obtainable, so that only the liquors rich in these acids can be worked profitably. Recent developments at the Manchester plant have indicated a method of increasing the phenolic content of the liquor, with obvious advantages in the recovery. This possibility was foreshadowed by work carried out at Coventry and elsewhere by the research staff of The Institution of Gas Engineers.[17]

If the gas liquors from 30 mill. tons of coal annually were worked for phenolic bodies with a two-thirds yield, some 15,000 tons of phenols would become available. This quantity includes the yield from coking plant liquors, which have generally less phenol content than have those from Gas Works. The crude tar from this coal would be, say, 1½ mill. tons, with a recoverable phenol content of, say, 3 per cent, or 45,000 tons. Thus the yield from liquors is by no means negligible in comparison with that from tar.

Attempts have been made to effect disposal of the liquor by evaporative methods, and one of these has been already referred to herein. There have been other methods of transferring the steam and toxic matter to chimney flue gases, and there have also been experiments in the direction of evaporating to produce steam for use in steaming retorts.[18] One difficulty, as will be imagined, is in choice of materials of construction. The success of a working-scale experiment was in one case adversely affected by the presence of fluorides in the liquor to be treated, which attacked a resistant metal since found to be satisfactory when used in another plant at the Partington Works of the Manchester Corporation Gas Department, and also on a coke oven plant. The former of these is treating a partly enriched chloride fixed liquor with success from the point of view of low maintenance cost and smooth operation, and it is believed also from the financial aspect.

A certain amount of effluent liquor and possibly a little crude liquor is being disposed of by the quenching of coke, but this is, one would hope, a practice which will not be used except under conditions unfavourable to any other means.

It will be seen that the statement earlier in this Paper as to the unsatisfactory position of the ammonia by-product is

justified in that the foregoing summary of alternative processes for liquor and effluent treatment does not disclose one which would have a fairly general application. At the present time, the only means of disposal of gas works effluent which can be effected with a fair certainty of the cost and the nature of the result is the treatment in bacterial sewage beds under properly prepared conditions.

Benzole

The technique of benzole recovery has received so much attention by writers of papers and by the Technical Press in recent years that it will have only brief mention in this Paper.

The more fundamental question of how the institution of benzole recovery affects carbonizing conditions and gas works economics has had as much attention, but the conclusions arrived at must be nearly as various as the yield of therms per ton. Out of the discussions on these matters, the following points have arisen:

(i) The lower limit of profitable extraction, in respect of gas output capacity, varies, being affected by local conditions such as type of carbonizing plant and prices of coal and residuals. Where simple carbonizing in horizontal retorts exists the limit may be very low, even under 40 mill. cu.ft. of gas per annum. On the other hand, a number of Gas Undertakings with continuous vertical retorts declare the extraction of benzole at the current selling price to be uneconomic, although they may have outputs of over 1,000 mill. cu.ft. per annum.

(ii) The primary consideration is nearly always the cost of additional coal, less revenue from additional residuals other than benzole. Generally the considerations are the same as those which have determined the choice of declared calorific value for the Undertaking, simply because it is calculated that the change is equivalent to the manufacture of a gas of a higher calorific value.

(iii) It has been found that in many cases the increase in coal purchases is not as great as is calculated. This has, in some cases, been taken as an indication that the retort house conditions before the change to a higher calorific value were not up to the best standard of efficiency, and that attention to these conditions would have been justified, even without the change of practice called for by extracting benzole, while maintaining the prior standard of calorific value. It is doubtful whether this contention covers the whole of the cases, or the whole of the facts in any case.

(iv) It is somewhat paradoxical that, taking the case of continuous vertical retorts, the extraction of benzole may be uneconomic at the low calorific value end of the scale, because of the large gas volume to be treated per unit of benzole, whilst at the high end it may be uneconomic because the calorific value cannot be raised by the required amount. On the other hand, if an Undertaking in the middle range cannot extract benzole and deal with the extra coke to be marketed, the question might be asked as to whether the calorific value chosen, without recovering benzole, was entirely justified financially.

(v) Intensification of gas selling propaganda will, if successful, produce the same conditions as result from the removal of benzole. Gas may conceivably be sold at a low price which will displace some of the Gas Undertaking's own coke. Do Undertakings put out two salesmen for coke as against one for gas?

During recent years there have been developments in coke oven construction directed to increase in benzole yield. There does not appear to be evidence of any such modifications in gas retorts, although the possibility of profits from benzole has been before gas engineers for some ten years at least. A gas richer in benzole would give its additional yield without any increase in operating cost.

One has heard in the past expressions of surprise at the lack of consideration shown to the carbonizing industries, in view of the services rendered to the country in the last war, not only in their normal duty of supplying gas, but in their power of supplying residuals. Will the Gas Industry be able to claim such consideration if it only produces those residuals which cannot very well be avoided?

In the estimation of the economics of the problem, there are two or three matters which are not always brought into the reckoning. Among them are the following:

(*a*) A reasonable proportion of benzole extraction is practically a guarantee of complete freedom from naphthalene, if the plant is worked with this in view.

(*b*) Removal of benzole is always accompanied by reduction in organic sulphur content. The ratio of sulphur removal is low for a partial benzole recovery, but rises rapidly with greater extraction. It has been estimated that ½d. per therm would not be an unduly high price for some Undertakings to pay for the benefits of a low sulphur gas, yet the difference in cost between recovering benzole up to 90 per cent and the additional cost of 75 per cent sulphur extraction is probably less than ½d. per 1,000 cu.ft., say, one quarter of the possible benefit.

(*c*) A somewhat contentious matter is whether extraction of benzole is accompanied by more, or less, gum production. On the whole the weight of evidence is in favour of benzole recovery, probably because of the tightening up of retort house conditions called for with a higher calorific value. At the same time, present knowledge can be applied to control gum formation quite independently of the benzole plant.[19]

The recovery of benzole to the extent of obtaining substantially all the toluene is a practicable expedient, as if the plant is capable of recovering, say, 1 gal. of benzole per ton, and the steam and temperature conditions in the distillation plant are satisfactory, the toluene will appear in the product. Such a plant will simultaneously provide for removal of the naphthalene, as it practically reproduces the conditions existing when a distilling unit is added to a naphthalene washer to regenerate the oil for further naphthalene extraction, and many of these plants are capable of extracting over 1 gal. of benzole per ton of coal.

Use of Exhaust Steam

It will be agreed that in the production of concentrated ammonia liquor or sulphate of ammonia by, for instance, the indirect method—which is most commonly used in Gas Works—the amount of steam required may vary from about 18 per cent of the weight of liquor distilled to 28 per cent, according to the type of plant and as to whether or not the fixed ammonia be treated with lime.

Taking a Works producing 3 mill. cu.ft. of gas per day, carbonizing 200 tons of coal per day and making 35 gal. of liquor per ton of coal, Table 2 may be constructed, assuming the recovery of 7 lb. of ammonia per ton of coal.

Thus it will be seen that for a reduction of 1d. per 1,000 lb. in the price of steam there is a saving of 7d. and 8d. per ton in the manufacturing cost of the concentrated liquor and sulphate of ammonia respectively. This represents a typical set of conditions, but a similar analysis could be made for any other particular case.

Table 2.—*Typical Results from Use of Exhaust Steam*

Strength of liquor: 2 per cent or 9.4 oz.—Total.
1.4 per cent or 6.6 oz.—Free Ammonia
Total liquor per day: 7,000 gal., say 71,500 lb.

——	(*a*) Free Ammonia	(*b*) Total Ammonia
1	2	3
Weight of 22 per cent concentrated liquor per day, tons	2·04	2·9
Weight of sulphate of ammonia per day, tons	1·79	2·54
Weight of steam used per day, free NH_3 only (20 per cent), lb.	14,300	—
Weight of Steam used per day, total NH_3 (28 per cent), lb.	—	20,000
Cost of steam per day, live steam 1s. 6d. per 1,000 lb.	21·5s.	30s.
Cost of exhaust steam, 6d. per 1,000 lb.	7·1s.	10s.
Saving by using exhaust steam per day	14·3s.	20s.
Saving per ton of products, 22 per cent concentrated liquor	7s.	6·9s.
Saving per ton of products, sulphate of ammonia	8s.	7·9s.

With regard to the application of exhaust steam to benzole distillation, possibly the best example is that of the vacuum distillation processes that have recently been adopted following the design of the plant for removal of organic sulphur compounds by the Gas Light and Coke Company at its Kensal Green Works.

The Authors are now considering plants for benzole recovery only, by vacuum distillation of the wash oil.

In these plants distillation at an absolute pressure of 9 in. to 10 in. Hg. allows a still-head temperature of under 90° C., and the temperature of the exhaust steam from the oil circulating pumps and vacuum pump is adequate to heat the oil to

this temperature, providing full heat exchange is effected between debenzolized and benzolized oil, and vapours and benzolized oil. In practice there is provided sufficient heat exchange to ensure that the total available exhaust steam will be adequate to heat finally the oil, and to provide also open steam to the still.

By this means a steam consumption as low as 22 lb. per gal. of benzole can be obtained when recovering 3 to 3·5 gal. of benzole per ton of coal. This should be compared with a figure of, say, 40 lb. per gal. of benzole under similar conditions when using live steam to the pumps and distilling at atmospheric pressure, effecting the major economy of using exhaust steam from the pumps as open steam to the still.

The use of exhaust steam for preheating gas before its entry to purifiers is generally accepted, and here it might be stated that the ammonia washer, situated as it frequently is, immediately before the purifiers, is very often a convenient source of such steam.

Thus it may be found in practice that the two by-product plants with the greatest demand for steam other than the purely gas making plant, namely, the ammonia distillation plant and the benzole recovery plant, require pumps, which themselves are consumers of high-pressure steam, and thus may provide a great part, if not all, of the steam as exhaust for the requirements of the plant. These two units can therefore be designed substantially to a steam balance to be as self-contained as possible. Under such conditions the main further conservation is in the exhaust steam from the works exhausting plant.

There are many installations of water gas plant in this country and abroad where, for the "run", exhaust steam is provided from a low-pressure accumulator collecting the exhaust steam from the turbine or engine driving the blower. In certain instances steam from pass-out turbines or from compound engines has been used for steaming vertical retorts or chamber ovens.

It can be shown that the amount of waste steam from an exhauster engine is an appreciable proportion of that required for steaming in vertical retorts and it should at the same time be remembered that heating up of feed water for boilers, particularly if softened, could be effected simultaneously in the gas condensers, or by the exhaust steam from fans on waste heat boilers.

The following calculations may be of interest:

Capacity of carbonizing unit, cu. ft. of gas per day	5 mill.
Make per ton, cu. ft. at 510 B.Th.U. gross per cu. ft. ...	15,000
Coal carbonized per day, tons	330
Pressure rise through exhauster, in. w.g.	48
Power for exhauster engine, b.h.p.	38
Steam per b.h.p. hr. at required back pressure, lb.	65
Exhaust steam available per hr., lb.	2,500
Coal carbonized per hr.	13·75 tons = 30,800 lb.
∴ Exhaust steam, per cent of coal carbonized	8·3

It is suggested that this quantity of steam could be applied to the steaming of the vertical retorts, augmented, if necessary, by high-pressure steam, which, if admitted at the steaming nozzle entry at the retort, would dry the exhaust steam.

Controls

A matter of interest which is relevant to the consideration of ammonia concentration and benzole recovery plants is that either of these recovery units is now available in a form which can be kept completely under control without constant attention. This is largely due to the use of automatic instruments.

The saving of three-shift labour on such plants represents the sum of £500 to £700 per annum, and obviously a saving of this magnitude will make the whole of the difference between economical and uneconomical working in a great number of cases. The controls make it possible to work with supervision only, exercised usually by operators who have other duties to perform.

Organic Sulphur

The practice of organic sulphur extraction by oil washing has recently assumed prominence. The actual overall cost, as has just been noted, is not prohibitive. In its more recent form the plant can be supplemented by equipment which will permit of a reduced benzole extraction whilst maintaining a high sulphur removal. As in the general case of benzole recovery, it is not proposed to discuss plant technique, as this has been treated thoroughly in communications of sufficiently recent date.[20]

Purification

With regard to oxide purification, there appears to be little to report in respect of plant construction, except to mention the recent Paper on the tower installation at Wandsworth,[21] and a certain amount of construction of box purifiers in steel, which was also, of course, the material used in the Wandsworth plant.

It is to be expected that there will be some attention paid to the possibilities of at least partial purification by liquid reagents. There has been a tremendous amount of investigation of these processes, and a recital of various suggestions would take very long, and would necessitate going back many years. The present war conditions are producing a shortage of the more acceptable forms of purifying oxide, and whether or not the strong position of oxide purification will be permanently affected, it seems that a case might possibly be made for partial liquid purification at the moment as an emergency measure.

If the sulphur from the gas could be made available in the form of free sulphur, or even directly converted to sulphuric acid, it would probably suit current conditions better than the full purification by oxide. On the other hand, the use of the oxide box often purifies the gas of a good deal more than sulphur, a fact which is deplored very much by the purchaser at times; this is not to be counted altogether a defect, however, from the gas engineer's point of view.

THE FUTURE

The process of gas manufacture will inevitably involve for many years to come the production of coal by-products, because there is at the moment no positive alternative proposal for gas production other than simple heating. In any case, the considerable mass of capital invested in the existing carbonizing plant will dictate adherence to present methods until some very definite alternative is provided. The increases taking place now in purchases of gas from coking plants also tend to perpetuate the standard conditions of gas manufacture.

The alternative processes are generally termed complete gasification processes, and they could logically be carried on so as to produce no by-products as residuals for sale. In fact, there is a school of thought in the Gas Industry which insists that as time goes on the importance of residuals is gradually disappearing, and that the point may be reached when the prices realized for residuals may be so low that the gas is virtually subsidizing their sale.

It is true that the familiar by-products are generally impure materials, which may fare badly in competition with the synthetic chemicals being offered in such abundance by the alcohol, carbide, and natural gas industries, but the point must not be overlooked that improvements in the preparation of coal products for the market may still be expected.

A matter which is not apparently always appreciated by advocates of complete gasification as a working policy is that unless the Gas Industry holds its whole fuel market, it will actually lose ground. Hence a crucial test for an alternative process will be that the gas so made will command a substantial proportion of the present coke market. In other words, large consumers of gas must be supplied at prices not much higher than 1d. per therm, at present values. There is at least as great a possibility that such a state of affairs would arise by the concentration of carbonizing plant in larger units, and particularly with wider regional planning.

Naturally, if legislation were passed to enforce the use of smokeless fuels in cities, the value of coke would rise to a point which would alter the conditions very favourably to carbonizing by means such as are now in use, but a secondary result might be that the demand and price obtainable for gas would increase, and thus bring complete gasification into a position more nearly approaching practical politics.

The present international troubles are, unfortunately, likely to immobilize capital for many years to come, and to have a very great effect on all fuel values, which is difficult to assess. The immediate effect will naturally be to cause an increase in the price of coal and its products, in which the by-products will share. At such a time, the importance of realizing the full value of each ton of coal carbonized is multiplied.

APPENDIX 1

ECONOMICS OF GAS CONDENSING

RESULTS OF 24-HR. TEST ON INTERMITTENT VERTICAL CHAMBER INSTALLATION AT THE WILLOUGHBY LANE WORKS OF THE TOTTENHAM AND DISTRICT GAS COMPANY

(Average gas make of 220,000 cu. ft. per hr.)

——	Condenser 1 (Using Frame-Cooled Water)	Condenser 2 (Using Make-up Water)
1	2	3
Gas inlet, °F.	184	99
Gas outlet, °F.	99	62·5
Water in, °F.	74	57
Water out, °F.	106	87
Water flow, gal. per hr. ...	33,000	2,100

COMPARISON OF COSTS OF TWO SYSTEMS

(*a*) Using town water only.
(*b*) Circulating water through primary condenser and over a cooling tower, adding make-up at secondary condenser.

System (a)

Flow of town water only, gal. per hr.	13,000
Cost per hr. of water at 1s. per 1,000 gal.	13s.

System (b)

Flow of town water for make-up, gal. per hr.	2,100
Cost per hr. of water at 1s. per 1,000 gal.	2s. 1d.
Cost per hr. of power for circulating water, 17 kW at 1d. ...	1s. 5d.
Cost per hr. of water softening at 4d. per 1,000 gal. (2,100 gal. per hr.)	8·4d.

BALANCE SHEET FOR DAILY OPERATION

Town Water Scheme, (*a*), pence per hr.		Circulating Scheme (*b*), pence per hr.	
Town water	156	Pumping	17
		Make-up water	25
		Softening make-up ...	8
		Attention, 1 hr. per 8-hr shift at 2s. per hr. ...	3
	156		53

Balance in favour of circulating system	103d. per hr. or £10 6s. per day
Saving per year of 365 days in case of base load plant or	£3,750
Saving per year of 250 maximum days	£2,570
Capital cost of cooling tower and pumping system ...	£2,500
Capital charges on cooling tower and pumping system at 12½ per cent.	£310 per annum
Annual saving: (365 days)	£3,440
(250 days)	£2,260
= approx. 0·45d. per 1,000 cu. ft. of gas	

The data from which the above has been compiled were kindly supplied by Mr. H. C. Smith, Chief Engineer, Tottenham and District Gas Company.

APPENDIX 2

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Gas Meters

Communication No. 232 (abridged)

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Samuel Clegg's first attempt at the invention of a meter was based upon the use of two bladders in tin containers, using mercury-sealed valves, but the membranes he used would not stand up to the impurities in the gas. He therefore turned his attention to the principles of measurement by liquid displacement, starting from the gasholder and setting himself the task of converting its reciprocating motion into a rotary one. His efforts, and those of Malam and Crosley which followed, passed through a number of stages becoming more and more complicated, but ending with the extremely simple device known as the Crosley drum, which should rank as one of the most important inventions of the early 19th century. Samuel and John Crosley were the proprietors of a factory in Cottage Lane, City Road, London, where in 1816 they manufactured meters under the patents of Samuel Clegg and John Malam. The Crosley drum is a really scientific instrument, the accuracy of which is qualified only by the physical vagaries of the gas which it measures. To illustrate its simplicity and effectiveness, it can, if fitted with two spouts, inlet and outlet, be placed on bearings in an open tank of water and will measure gas accurately without any mechanism other than a counter for its revolutions.

The wet meter held the field undisputed in this country for only two or three decades, while the dry meter was being developed. Then began a competition between the two types, lasting until the end of the century, when the wet meter was virtually withdrawn from the conflict so far as domestic meters were concerned. It was a struggle of general convenience against academic accuracy—and convenience won. The liquid seal, the weight and the bulk were the deciding factors against the older instrument. It is possible to speed up the dry meter and greatly increase its capacity for a given size, but the capacity of the Crosley drum is restricted by its pressure absorption, inasmuch as its rotating compartments are forced through the liquid in the course of displacement and the resistance set up thereby increases as the square of the speed. Moreover, such pressure absorption affects the accuracy of registration by its effect on the level of the sealing liquid.

Some 25 years ago an attempt was made to revert from the rotary to the reciprocating movement, resulting in an instrument known in France as the "Sigma" meter. This was introduced into this country in 1925 and from this was developed the "Bell" meter. With the simple rise and fall of the measuring container in this type of meter, there is no forcing of partitions through the liquid, and any increase of pressure absorption with speed is limited to inertia and the friction of mechanical parts. This meter can therefore be run at a speed which will treble the capacity for a given size with less pressure absorption than that usually required by the Crosley drum. Theoretically the "Bell" type should be the most accurate of all meters, inasmuch as the rise-and-fall action makes it independent of the fixed liquid level (within limits), and in the larger sizes it can be made independent also of the fluctuations in liquid level due to pressure absorption. Unfortunately, however, this type of meter, in contrast to the Crosley drum, requires mechanism—slide valves, connecting rods, crank, etc.—very similar to the dry meter, and accuracy may be affected by wear and tear on these parts.

The Sigma meter made by the French Meter Company uses oil for the sealing liquid. It is free from the disadvantages of the dry meter associated with slide-valves and mechanism, because these parts receive regular lubrication from the oil atmosphere within the meter, and so far as the measuring chambers are concerned, the accuracy is positive. While some 90 per cent of the meters in France are of this type, British practice has never quite forgiven the wet meter for its inconveniences, and it would not be easy to re-introduce in this country a type using oil, and one so difficult to equip with fraud-preventing devices.

The " B.M." meter shares with the larger sizes of Bell meter the advantages of the rise-and-fall action, and the independence of the fixed liquid level, but, in common with the Crosley drum, it is susceptible to the error due to fluctuations of liquid level by pressure absorption. It is, however, free from the disadvantages of the valve mechanism necessary in the Bell meter.

The Crosley drum has recently been produced in a modified form based on considerable research, by means of which its capacity is increased for a given size. This is accomplished by enlarging the centre opening and adjusting the angle of the partitions so that there is greater freedom in liquid displacement and a minimum of liquid resistance. The result is an increase of as much as 50 per cent in throughput for a given pressure absorption, or, conversely, for the same throughput a considerably reduced pressure absorption, making for enhanced accuracy.

The question has often been asked as to the degree of accuracy which can be guaranteed in a wet station meter. Theoretically the accuracy is absolute, i.e., so far as passing unregistered gas is concerned, for the gas is being measured by displacement of a liquid. In practice it may be tested over and over again and a slightly different result obtained each time, due to the difficulties encountered in corrections for temperature, pressure and humidity, together with the possibility that the gas may lose constituents to the liquid by absorption or take up vapour therefrom. Owing, however, to the absence of any sufficiently large standard testing plant in this country, a station meter cannot be tested at its full capacity, and meters tested at low flows within the capacity of the testing plant available must then of necessity be assumed to be equally accurate throughout the whole range of their capacities.

The wet meter can never become wholly obsolete, so long as liquid displacement remains the statutory basis for the measurement of gases. First there is the volume of water under standard conditions; then displacement by the " cubic foot bottle ", from which is calibrated the reciprocating testholder; lastly the more portable Crosley drum, which still reigns supreme both in the laboratory and wherever the liquid level can have the attention it requires without resort to the variety of safeguards against contingency and fraud which have been the inseparable accompaniment of the consumer's wet meter.

DEVELOPMENT OF DRY METER DESIGN

The design of the dry gas meter is fundamentally the same as that patented by Croll and Richards* in 1844. Measurement is by filling and emptying four collapsible compartments, the gas flow being distributed by means of two slide valves. The original " lights " type of meter had large outer case dimensions with definitely restricted internal gasways and valves, resulting in small capacity and a relatively high pressure loss across the meter.

The investigations of the Life of Gas Meters Joint Committee of the Institution and The Society of British Gas Industries, consisting of gas engineers and meter makers, led to the " standard " range of meters in 1921. These standard meters, while retaining the unwieldy case sizes of the various manufacturers, were constructed with larger valves and gasways, disk-type leathers being introduced in place of the bellows type to give increased capacity per revolution, and to make possible some increase in speed. Following the lead given by the Life of Gas Meters Joint Committee, the manufacturers soon introduced the high capacity meter, which used the existing case sizes, but with further increases in capacity per revolution and a slightly higher speed, the main development being the utilization of all available space in the diaphragm chamber to obtain increased volume per revolution.

Further experimental work resulted in the small high-capacity meter adopted by the Meters Committee of the Institution in 1936, and known as the I.G.E. range. The greatly reduced case size necessitated reduced capacity per revolution but, by increasing the speed, increased throughput per hour was obtained, while pressure loss across the meter was reduced.

The only radical changes which have taken place during the foregoing evolution have been the introduction of the disk-type diaphragm, greatly enlarged valves and gasways, the " open top " meter (introduced at the time of the high capacity meter), greasing devices fitted to stuffing boxes, oiling arrangements for the valves and mechanism, and the enclosure of gearing in a gear box (applied to the " open top " meter only).

The single diaphragm meter has appeared from time to time and has a considerable market on the Continent. Although it can be made cheaply and has a high degree of accuracy, it is not a type which appeals to the Gas Industry in this country. Working with snap valves which reverse at the end of each stroke like a windscreen wiper, it ticks like a clock and cannot be easily adapted to the types of coin mechanism to which one is accustomed.

During the long period while gas was supplied for illuminating purposes only, the manufacturers made whatever improvements they considered necessary and since then the gas engineer, considering that design is the function of the manufacturer, has done little more than approve a range of case sizes, the dimensions of which were already in existence. The designer in this country, now limiting himself to the definite dimensions of the I.G.E. case sizes, expends his energies in achieving the best performance possible in these meters.

The size of case limits the size of diaphragm, and thus capacity per revolution is controlled within narrow limits. The diaphragms should be as large in diameter as the case size will permit, because the power to operate the meter is obtained through gas pressure on the diaphragms. The stroke is adjusted to give the requisite capacity per cycle, but this is of secondary importance compared with the diameter. Generally, a meter of given capacity will give better results if the length of travel of the diaphragms is reduced and the speed increased depending on the critical speed and other factors.

Leather troubles are today practically unknown, but as the leather portion is by its action the only variable quantity in the complete diaphragm, the amount of leather used should be kept to a minimum, and consequently the size of the stiffening disk is important. Any strain on the leather causes excessive pressure absorption, and as accuracy of registration depends largely on keeping pressure loss to a minimum, any restriction of movement causing absorption is to be avoided.

The valve plate must be accurately planned and the positioning of the flag rods which transmit the motion from the diaphragms needs care to ensure that the diaphragm disks will travel in a parallel motion without twisting and without distortion of the leather. The slide-valves should have inlet and outlet ports of ample area, the dividing walls between the ports being of the narrowest width possible consistent with safe sealing, and yet be rigid enough to avoid distortion and vibration. If the walls are too thin they act as tuning forks and are a cause of " squeakiness "; stiffening bars between the walls, however, tend to prevent this noise. The timing of the valves in relation to the diaphragms requires most accurate adjustment to avoid oscillation, with its resultant effect on registration. The theory of " cushioning " in a steam engine cylinder is applicable to gas meters.

The gasways in the meter from the inlet to the valves, from the valves to the diaphragms, and from the diaphragms and valves to the outlet, account for approximately 50 per cent of the total pressure absorption taken by the meter when working at its badged capacity. It is essential that the various gasways are designed of ample area and as smooth and free from changes of direction as possible, and that they are so disposed as not to be obstructed during any part of the cycle. Changes of direction and any form of baffling increases pressure absorption considerably, due to turbulence. Gasways too large are greatly preferable to those too small, but the size is limited by the dimensions of the meter case.

Very little need be said regarding the several fittings used in transmitting the motions of the diaphragms to the valves and the index, except to record that mechanical accuracy of design must be attained, otherwise the advantages gained by the design of diaphragms, valves and gasways are quickly lost by wear and increasing friction in service.

Stuffing boxes should be of ample length and packed carefully, so that the shafts and spindles can rotate or reciprocate freely without binding. Excessively tight packing in a stuffing box can cause sufficient friction to stop the action of the meter

* British Patent No. 10,096, 7th March, 1844. Croll, A., and Richards, W.

entirely. The "open top" meter has a definite advantage in this respect in that two of the stuffing boxes, those on the flag rods, require to seal only against the differential pressure across the meter, the only stuffing box required to resist the full inlet pressure being that on the index spindle. In the enclosed-valve type of meter all the stuffing boxes must resist the inlet pressure.

Domestic dry meters are constructed to meet all statutory requirements, and to some extent provision is made against many years of useful and accurate service by the provision of lubricating and greasing devices, but all too often the equipment so provided is neglected when the meter is in service. The mechanical parts of a meter ought not to be denied that attention by the user which is invariably given to machinery and mechanism used on the Gas Works where the gas is made. Such neglect in the lubrication of a meter leads to excessive friction and pressure absorption. This can seriously affect registration, with consequent increase in "unaccounted-for" gas and loss of gas revenue, to say nothing of its effect in shortening the life of a meter.

POSSIBLE FUTURE DEVELOPMENTS

The present-day dry gas meters, like those of early days, in so far as they comply with the statutory requirements are mechanically satisfactory, but it is interesting to consider how far they may be regarded as having been designed scientifically. It would seem that development throughout the century has consisted of improvements resulting from complaints or failures due in many cases to alterations in the commodity which the meters have been called upon to measure rather than to any inherent fault in the meter itself. In other words, progress has been by trial and error.

The accepted pattern of dry meter is in general principles very similar to the reciprocating steam engine, and having in mind the developments due to the application of scientific knowledge, by which the old-fashioned beam engine has become the totally-enclosed, pressure-lubricated, high-speed steam engine of today, one cannot help wondering whether a similar application of science would lead to a parallel development in the dry gas meter, resulting in a small, compact, highly sensitive and accurate piece of mechanism. Would such a meter be so small as to become an appendage to the prepayment mechanism and cash box? Several meter manufacturers have, in fact, constructed sample meters no larger in size than the cash box, having a capacity of 50 to 100 cu.ft. of gas per hr., and capable of accurate measurement, but the limits imposed by the location of the connexions on existing installations and the requirements of a fraud-proof prepayment mechanism have prevented such samples from becoming commercial propositions. Since very small meters with high capacities can be constructed, it would seem to be possible to build larger models which could be fitted into existing installations, but with a capacity far exceeding that of the present meters. At first sight this would appear to be a desirable development, but the advantage gained would in many cases be nullified by the small dimensions of the service pipes and internal fittings on consumers' premises.

It is suggested that scientific investigation into the whole question of gas meter design and operation is a matter of some importance to the Gas Industry. The Author is of opinion that the matter is of far more than academic interest, and that there is a strong economic interest: for example, standardization would tend to reduce meter costs; overloading meters causes slow registration and loss of revenue; neglect of lubrication leads to excessive friction, slow registration, loss of revenue and a high "unaccounted-for" gas figure. Moreover, the need for testing large meters throughout their range of capacities is growing with the increasing use of gas for industrial purposes. All these are matters which the Meters Committee of the Institution is peculiarly well fitted to investigate.

STANDARDIZATION

It is gratifying to note that the gas engineer, as represented by the Institution, has during recent years taken some part in the development of the dry meter. In October, 1914, a Joint Committee of the Institution and The Society of British Gas Industries was appointed to investigate the "various conditions affecting the life of gas meters," but it should be pointed out that the interest arose because gas engineers, who had for generations merely accepted the gas meter as a necessary part of their equipment, began to be seriously troubled by the growing tendency for the meters to develop senile decay at a comparatively early age. The terms of reference of this Committee, as defined in its 1916 Report, were:

(i) Effects of position of meters when in use.
(ii) Liquids in meters.
(iii) Action of gas upon meters.
(iv) Decay of leather.
(v) Internal corrosion.
(vi) Deposit on valve faces.
(vii) Naphthalene in meters.
(viii) In a given time, is more work being put on meters than heretofore?

It is not surprising that at first the Committee concentrated its attention on the various aspects of corrosion. One important result of eight years' work was the recommendation by the Committee with regard to lubrication of gas meters, both when new and when installed on consumers' premises. Another result was the attempt at standardization, resulting in modifications to the internal mechanism of the meters, enabling existing sizes of meters to be rated at higher capacities. There is little evidence that these modifications of the internal mechanism or even the decision to retain existing case sizes were anything more than the acceptance of composite designs incorporating a number of different suggestions for increasing the capacity of existing patterns of meters.

The advantages of the standard meter, as it was called, were not appreciated by the whole of the Gas Industry, with the result that the manufacturers had to build and stock the additional patterns of meters without any of the old patterns becoming obsolete. The lead given by these recommendations of the Committee resulted in the production of a high capacity and later a small high-capacity meter. Both patterns found favour amongst sections of the Gas Industry only, with the further result that the manufacturers became over-burdened with the number of different patterns of meters which had to be manufactured and stocked. Added to this variety of productions were specifications by different gas engineers, to meet so-called local conditions. Such a state of affairs militates against reduction in the costs of manufacture, and this was realized by the more recently appointed Meters Committee of the Institution, which, in 1936, stated in its 1st Report that it was "impressed with the need for a reduction in the number of classes and sizes of meters", and in its 2nd Report recommended schedules of gas meter case sizes, and dimensions of connexions, which should be accepted by the Industry as standard. The Report continues: "Unless the specification hereunder is generally adopted by the Gas Industry, the desired reduction in the number of classes and sizes of meters will not be effected and the position, instead of being improved, will be further complicated. It is recommended, therefore, that Gas Undertakings should in future order gas meters to comply with 'The Institution of Gas Engineers' Specification for Gas Meters for Domestic Consumers.'"

In presenting the Reports, Mr. J. Terrace, Chairman of the Meters Committee, expressed the hope that adoption of the schedules would lead to reduced costs. Unfortunately the recommendations have not as yet been accepted by the whole of the Gas Industry, and the efforts at standardization have met with little success. When one considers that there are still engineers who demand meters of the older types there seems little prospect of the manufacturers being able to reduce their costs. A firmer stand might well be taken by the manufacturers in the interests of the Gas Industry as a whole, to establish the I.G.E. range of meters at prices which would give a reasonable margin of profit and to charge appropriate extra prices for all departures from these standards. A national characteristic is dislike of regimentation or rigid standardization of any kind, but few will refuse to admit that some measure of standardization is not only desirable but should be enforceable, and it is hoped that a greater interest will be awakened in this aspect of the difficulties of the Meter Industry.

EFFECT OF OVERLOADING METERS

Members of the Institution are well acquainted with the variations of pressure loss across a meter, and many will have made charts for different makes and types of meters showing the pressure absorption for different flows of gas. They are aware, too, that a proportion of the pressure is absorbed by the mechanical friction of the moving parts of the meter and the remainder by the flow of the gas through the various gasways and valves. By removing the diaphragms and tangent links of a meter and by setting the valves in suitable positions, the

gas can be given a passage from inlet to outlet, through the gasways and valves, free from the resistance due to the motion of the parts. In this way tests can be made to obtain the pressure absorbed by the gasways alone for different rates of flow. From such tests a chart can be prepared similar to that of Figure 1. At the same time, figures can be obtained showing the accuracy of registration at the various flows, up

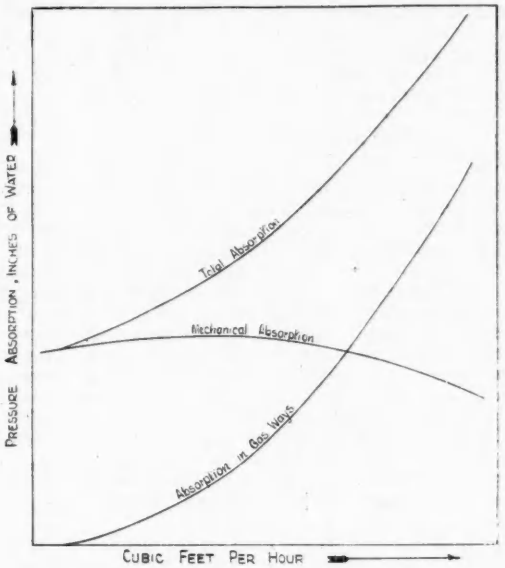


FIGURE 1.—*Pressure Absorptions due to Gasways and Mechanism with Clean Dry Valves for Different Throughputs of Gas.*

to the maximum capacity of which the meter is capable, and it is found that as the pressure absorption increases the registration tends to become " slow ". Meter manufacturers pride themselves on their ability to build meters in which the accuracy of registration even at flows in excess of the badged capacity remains within the legal limits, but there is, of course, no guarantee covering accuracy when the meter is overloaded. In his own interests the engineer will avoid overloading

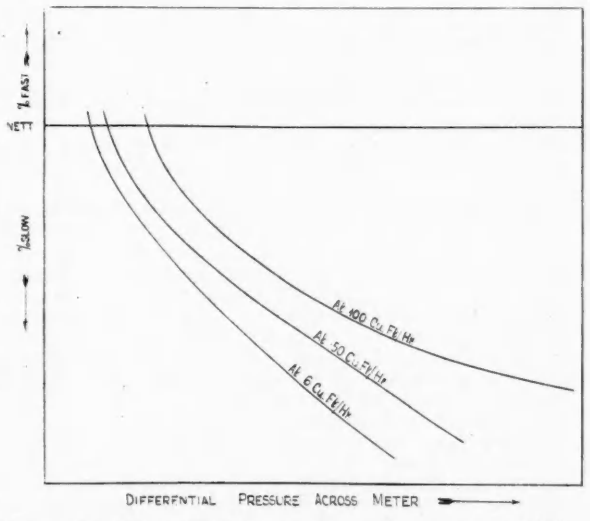


FIGURE 2.—*Effect of Pressure Absorption across a 100-ft. S.H.C. Ordinary Meter on Registration.*

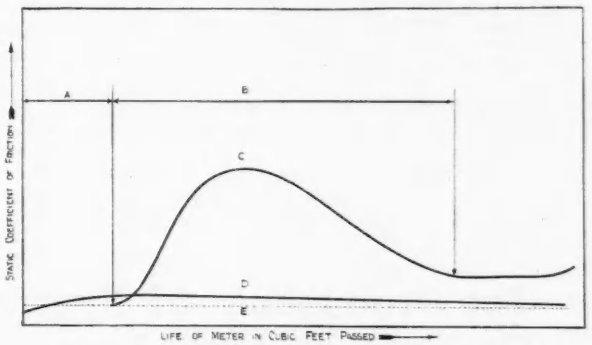
because any lowering of the accuracy of registration which takes place, however small, means some addition to the total of " unaccounted-for " gas, and some loss of gas revenue.

It will be appreciated that while the foregoing applies to meters when they are new, the pressure absorption and loss of accuracy increases considerably with the age of the meter. In order to estimate the rate of this increase, it is possible to simulate increasing friction of the moving parts by attaching an adjustable friction clutch to the index shaft of the meter. While passing gas through the meter on the test bench, the clutch can be set to cause any desired pressure absorption for a given rate of flow of gas. The accuracy of registration under such conditions is then obtained. A series of registration figures for different flows and different conditions of friction and pressure loss will enable a chart to be built up similar to that in Figure 2. While overloading of a new meter may have only a small effect on " unaccounted-for " gas, the same degree of overload on an old meter suffering from slightly sticky valves or other causes of mechanical friction, can cause very severe losses of revenue—far more than would pay for a larger meter.

The Author suggests that a more thorough investigation of this matter by the appropriate technical committee of The Institution of Gas Engineers would lead to information of value to the members.

EFFECT OF NEGLECTING LUBRICATION

It can be shown that where clean, unlubricated valves and covers are employed in a meter measuring clean gas of consistent quality, the coefficient of friction between the cover and the valve remains fairly constant throughout a long period of life, but unfortunately clean gas of consistent quality is not universal throughout the Industry and lubrication is as necessary today as when it was recommended by the Life of



A. Period of Constant Lubrication Depending on Amount of Oil Initially Sprayed into the Meter.
B. Period while Oil Film wears away.
C. Valves Lubricated and then Run without any Renewal of the Oil.
D. Dry Valves.
E. Constantly Lubricated Valves as a Result of Periodic Renewal of the Oil.

FIGURE 3.—*Varying Coefficients of Friction of Gas Meter Slide Valves after Lubrication with Solar Distillate Working in Clean Gas (Subject to Variation Due to Action by Different Constituents of the Gas).*

Gas Meters Joint Committee in 1921. When clean, dry and properly-ground valves are lubricated with solar distillate, the oil most commonly specified, the static coefficient of friction is immediately increased owing to the viscosity of the oil. As the oil film is worn away, it reaches a point where surface tension makes it a sealing medium and the coefficient of friction increases to 10 or 20 times its original figure, with resultant increased pressure loss through the meter, and straining of the mechanism and diaphragms. When the oil film is almost completely worn away, abrasion of the metal takes place on unlubricated portions of the valve and forms a paste with the residues of oil in the minute hollow spots of the ground surfaces, producing extremely smooth surfaces which tend to stick together.

It is possible that many of the so-called gum troubles may in fact be the direct result of lubrication commenced and then neglected. Thus, while experience proves the advantages of lubrication, common sense, supported by evidence, dictates that such lubrication should be continuous and not spasmodic. That the film of oil between the valves and covers does wear away, with the results stated, can be demonstrated easily by running the valves at normal working speeds in a gas atmosphere, and periodically testing them to find the coefficients of friction. Numerous tests have given very consistent results and, when charted, produce a graph similar to that in Figure 3. Further investigation is required to determine the effects of various constituents in the gas under different conditions of temperature and pressure.

Most Gas Undertakings and meter manufacturers have experience of meters returned from the district for pressure

absorption, which on the test bench have shown registrations of 5, 10, 15 per cent or more " slow ", and then after being sprayed with a suitable oil have quickly recovered their accuracy. By the use of graphs built up on the lines indicated in the Paper, it is possible to form some idea of the financial loss sustained by the Gas Undertakings in respect of these meters. In Table 1 are given examples of losses due to neglected lubrication and these have been taken from meters of different makes and different districts, and are given as a matter of interest. While they are approximate figures only and possibly wide of the mark, they do indicate that the Gas Industry might well consider taking steps to introduce a system of periodic lubrication of meters *in situ*, if it can be done simply and cheaply.

Investigation tends to show that the initial charge of oil injected into a meter before leaving the makers' works may be sufficient when the meter is finally installed on the consumer's premises to last for a period, while the meter passes, say, 15,000 cu.ft. of gas. Before the end of that period is reached the oil should be replenished. One suggestion for doing this easily and cheaply is to fit the meter with a simple nipple to enable a small quantity of oil to be squirted on to the valves and valve plate, sufficient to last for several months.

TABLE 1.—*Examples of Losses due to Neglected Lubrication*

Ref.	Year of Make	Total Gas Registered, cu. ft.	Test Result, per cent. Slow. at 50 cu. ft. per hr.	Estimated Losses		
				Short Registration	Cost of Changing	Total
1	2	3	4	5	6	7
				s. d.	s. d.	s. d.
A	1938	50,200	9·9	17 5	2 6	19 11
B	1937	41,000	14·1	14 9	5 0	19 9
C	1938	36,600	15·3	15 6	6 0	21 6
D	1937	70,900	5·2	13 9	4 6	18 9

Most Gas Undertakings pride themselves on their maintenance schemes for consumers' appliances, involving periodic visits to every consumer. If a small oil-gun is added to the equipment of the maintenance fitters, a few minutes only would be required to give the consumer's meter a shot of oil at regular intervals. Sufficient oil could be injected to ensure that lubrication would be practically continuous until the next visit of the fitter. The cost to the Undertaking would be small and would be more than repaid by preventing slow registration and loss of revenue, by the saving of expenditure on meter changing, and by lengthening the life of the meters.

Surely this is a subject worthy of being more fully investigated by the Meters Committee of the Institution.

REGISTRATION OF LARGE METERS

Many workers in the Gas Industry have from time to time investigated the effect on " unaccounted-for " gas of the varying conditions of temperature and pressure on consumers' premises, met with in the vagaries of this climate, and it would be interesting and instructive to investigate what proportion of " unaccounted-for " gas is the result of proving and stamping meters under laboratory conditions and then putting them into service in positions where they are subject to variations of temperature, pressure and corrosive influences which are not reproduced in the proving room. The growing use of large meters for supplies of gas for industrial purposes gives such an investigation an added importance, and it is to be regreted that more active steps have not been taken to provide facilities for testing large meters up to their normal capacities. Usually the largest test-holder in a testing station has a capacity of 20 cu.ft. only, whereas loads of 50,000 cu.ft. per hr. are not uncommon for many industrial processes using gas today.

It will be seen, therefore, that the existing legislation drawn up in 1859 and amended by Statutory Rules and Orders No. 2354 in 1920 are hardly adequate to cover present-day requirements.

The Production of Reactive Gas Coke by Alkali Activation

Communication No. 233 (abridged)

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The experiments were carried out in a setting of four Woodall-Duckham upwardly-heated vertical retorts which form one unit of an installation of 16 retorts at the Garston Works of the Liverpool Gas Company. The dimensions of the retorts are 25 ft. long by 74 in. by 10 in. at the top, and 82 in. by 18 in. at the bottom, the nominal capacity being 8·0 tons per day.

It was essential to ensure that the required amount of alkali was adequately mixed with the coal, and that there was no segregation in the handling prior to carbonization. Previous experience had shown that the mixing of about 2 per cent of alkali with a nut coal and the prevention of such a blend from segregating in the bunker was an extremely difficult matter.

With the assistance of the Woodall-Duckham Companies a feeding device was designed to deliver the alkali mixture at a constant rate to the stream of coal passing to the crusher. With the nut coals used the crusher simply functioned as a primitive kind of mixer. The problem of feeding the alkali was complicated by the nature of the material, which is liable to pack and arch in hoppers of the conventional type with tapering sides. Consequently the alkali storage hopper was constructed with three sides vertical and the fourth side tapering as little as possible. A hopper of this nature would have been impracticable with an outlet of normal size, and the capacity would be inadequate unless the height was made excessive. This difficulty was overcome by using a Redler " Abstractor Conveyor ". This conveyor consists of a chain running in an enclosed trough of rectangular section. Such a chain will convey material with a depth in the trough much greater than that of the individual link members of the chain. It is generally possible to convey a depth of material equal to the width of the chain, and as there is no relative movement between the individual particles of the material conveyed and the chain itself, this type of conveyor makes an excellent feeding and measuring device.

With the arrangements made the discharge of alkali on to the coal was found to be extremely uniform. The rate of alkali feed could be controlled both by variation of the chain speed and by varying the depth of alkali in the trough by a trimmer plate.

During these experiments the alkali has been added as finely-ground limestone mixed with light sodium carbonate before charging to the alkali hopper.

The next problem was to prevent the segregation of the coal and alkali in the bunker over the retorts.

For the experiment at Garston the compartmenting of the bunker was effected by the method described by Peacock (*J. Inst. Fuel*, 1938, 11, 230). This system has worked extremely well and has entirely prevented any serious unmixing of coal and alkali. It was found, however, that some local segregation of alkali tended to occur when very dry coal was used, particularly with large nuts. This had been overcome by fitting a finely-atomizing water spray over the jigger feeders so that the coal is moistened just before the alkali is added. The amount of water added was never more than 1 per cent but it was sufficient to enable the alkali to stick to the coal until the mixture was uniformly distributed in the bunker.

Some experiments have also been made in an isolated test retort at the Athol Street Works. For the purpose of blending alkali with a coal in this case, a " Trayco " electric vibrating conveyor was used to add alkali to the coal in a horizontal run of the bucket elevator system. As at Garston, a water spray was used just prior to the alkali addition. The Authors do not consider that the " Trayco " is a very suitable device for adding a controlled amount of alkali, as the output varies with fluctuations of the voltage of the electrical supply. In these experiments, which were of relatively short duration, the " Trayco " was hand-controlled, but for continuous addition this could scarcely be possible and errors of addition would undoubtedly occur.

CONDITIONS OF CARBONIZATION

When these upwardly-heated settings were first installed in 1935, it was thought probable that the production of a fuel with the characteristics of "Dryco" would be more difficult than was the case in the downwardly-heated retorts which had previously been used. This proved to be so and the greatest care is exercised to prevent excessive heat treatment of the coke; this is equally necessary when the increased combustibility is to be obtained by the addition of alkali. The control is effected by careful adjustment of the combination of maximum temperature and rate of coal throughput. The condition found to be most suitable was a bottom temperature of 1,320°-1,340° C., top temperature of 1,030°-1,060° C., and a throughput of 8·3 tons per retort day. A well-carbonized coke was produced in this way, using a Staffordshire gas coal. A variety of steaming rates was used and it was found that owing to the increased reactivity of the coke the steaming percentage could be considerably reduced without increasing the calorific value of the gas above that produced under normal conditions with the untreated coal. When the process had been in operation for 12 months the second stage combustion was put into use. Provision is made for this in the design of the setting, and in this way the maximum temperature at the bottom is reduced to 1,280°-1,300° C., the top temperature increased to 1,080°-1,100° C., and the heat treatment to which the coke is subject is not so severe. At this stage some erosion of the retort wall at the extremity of the major axis in the steaming zone was noted. This was considered to be caused by an excessive rate of ash release due to the increased reactivity of the coke, and the two-stage heating was adopted in order to lower the temperature and to spread the steam effect over a greater area of the retort wall.

The volatile matter content of the coke was only slightly affected by the lowering of the maximum temperature and there was a notable increase in the reactivity due to the less severe heat treatment in the steaming zone.

EXPERIMENTAL RESULTS

"Dryco" has a bulk density of about 18 lb. per cu.ft. when graded ⅝ in. by 2 in. It has a volatile matter content of 2-3 per cent, an ash content of about 6 per cent, a C.A.B. of about 0·040, and ignites with 4 cu.ft. of gas or less in a standard Metro grate. Its reactive properties enable it to be used in most ordinary types of coal grate, in which it can also readily be ignited by means of paper and sticks. The process differs from that described by J. Jamieson and J. G. King in that approximately normal high-temperature carbonizing conditions are used and the volatile matter content of the fuel does not normally exceed 2·5 per cent.

In the preparation of alkali activated coke it had to be remembered that the addition of alkali inevitably increased the ash content of the coke, and the process could not therefore be so satisfactorily applied to coals containing a relatively high ash content. For the main run of the test a Staffordshire coal was selected, which had a reasonably consistent average ash content of 4·3 per cent (dry basis). Tests made over a long period showed that the ash content seldom rose above 5 per cent. Other coals used in short tests were from South Yorkshire, North Wales and Lancashire. All these had a dry, ash-free carbon content of 83-84 per cent.

PROPERTIES OF THE UNTREATED COKE

The normal carbonization of this coal gave a coke which was moderately reactive but which was not suitable for ordinary open grate use. In Table 1 are given the C.A.B.* determinations and ignition tests made on several samples of the unactivated coke with different degrees of steaming.

The lack of correlation between the C.A.B. and the ignition values is very curious. It would appear, however, to be due to the difference in steaming rates. With a high steaming rate it seems that more porous coke is produced, giving a relatively easy ignition in the grate, in spite of a high C.A.B. With the lower steaming a stronger ignition is required although the C.A.B. is in most cases lower. These results seem to show that the C.A.B. may not always be a reliable guide to the behaviour of the coke in an open grate, and account must also be taken of the conditions of carbonizing.

PROPERTIES OF THE ACTIVATED COKE

The amount of alkali added to the coal was 1·25 per cent $CaCO_3$ (=0·7 per cent CaO) and 0·5 per cent Na_2CO_3. This increased the ash content of the coke after grading from about 6 per cent to about 8 per cent on the average. This ash content has to be compared with that of normal "Dryco", which averaged 6 per cent. It was observed that the ash from the activated coke was denser than that from "Dryco". Actual measurement gave a pouring density of 0·45 g. per c.c. for the activated coke ash and 0·36 for "Dryco" ash. This showed that in spite of the higher percentage ash in the activated coke the ash volume from a given weight of coke was the same as for "Dryco".

TABLE 1.—*C.A.B. Determinations and Ignition Tests*

Sample No.	Steam Pressure to Retort, lb. per sq.in.	Combustion Chamber Temperatures, °C. Average		Volatile Matter, per cent	C.A.B.	Gas for Ignition, cu. ft.
		Top	Bottom			
1	2	3	4	5	6	7
162	18	1,110	1,360	0·63	0·067	5½
161	16	1,140	1,380	—	0·064	5½
178	16	1,060	1,330	—	0·058	5½
140	8	1,080	1,345	0·85	0·056	8
142	8	1,070	1,340	2·16	0·060	7½
234	8	1,080	1,340	1·44	0·058	8

PROPERTIES OF THE ALKALI ACTIVATED COKE

Determinations of the volatile matter contents were made by the nitrogen tube method. A number of results for samples of coke taken during the period of the test are given in Table 3. These are on the average slightly higher than for the untreated coke.

In Table 2 are given the volatile matter contents of samples of coke taken after the introduction of two-stage heating.

TABLE 2.—*Volatile Matter Contents of Samples of Coke*

Weekly Average Sample	Moisture, per cent	Volatile Matter, per cent
1	2	3
November 20-25, 1939	1·42	3·08
December 4- 9, 1939	1·67	2·60
December 18-23, 1939	1·62	2·89
January 1- 6, 1940	1·66	3·38
January 22-27, 1940	1·86	2·09

These show very little change in the volatile matter contents as a result of the modified method of heating the retorts.

Reactivity

A general check on reactivity has been maintained by ignition tests in a standard Metro coke grate in the same way as had previously been used for "Dryco". The standard adopted was ignition by 4 cu.ft. of gas or less. At the same time, a number of C.A.B. tests have been made, and examples of these are recorded in Table 3, together with the corresponding values of the gas ignition and the volatile matter content. Average combustion chamber temperatures are recorded. The coal throughput of the retorts was between 8 and 8·5 tons per day.

Before 5th December, 1938, the coal was not systematically wetted prior to the addition of alkali. The variations in reactivity which were apparent before that date were traced to the periodic occurrence of dry coal, giving rise to local segregation, with the result that there was reduced efficiency in activation. It was also considered that the retort temperatures were rather too high to allow of complete avoidance of over-coking, and for the main run of the test these were stabilized at approximately 1,025° C. (top) and 1,330° C. (bottom) until the introduction of two-stage heating, when the average temperatures were 1,080°-1,100° C. (top) and 1,280°-1,300° C. (bottom).

It will be seen that the reactivity of the coke remained remarkably constant during the main run of the test with an ignition value of about 3 cu.ft. of gas and a C.A.B. of about 0·040. The volatile matter content of the coke was mainly between 1·0 and 2·5 per cent. The changes in reactivity recorded in the table may appear small numerically. It has been found, however, that in a prolonged experiment of this nature the operators became remarkably skilful at estimating ignition values, and these small changes have proved to represent real differences in the burning properties of the coke, when used in an ordinary coal grate.

In Table 4 is given the complete grate tests of a sample of alkali activated coke compared with normal "Dryco"

* C.A.B. tests have been carried out according to the modified method proposed by the Midland Coke Research Committee and described in *Fuel in Science and Practice*, 1937, **xvi**, 361.

TABLE 3.—*Examples of C.A.B. Tests, with Corresponding Values of Gas Ignition and the Volatile Matter Contents*

Date	Steam, lb.	Combustion Chamber Temperatures, ° C. Average.		Volatile Matter, per cent	Coke, C.A.B.	Gas for Ignition, cu. ft.
		Top	Bottom			
1	2	3	4	5	6	7
1938						
Oct. 10	10	1,060	1,330	1·69	0·048	4
15	10	1,060	1,330	1·57	0·042	4
18	10	1,050	1,335	—	—	3·5
21	8	1,050	1,335	2·42	0·040	3·5
24	8	1,060	1,330	1·83	0·042	2·5
27	8	1,060	1,330	—	0·046	3·5
28	8	1,060	1,330	2·60	0·048	4
Nov. 2	8	1,065	1,350	2·92	0·048	3·5
7	8	1,070	1,340	2·82	0·046	4
10	8	1,100	1,350	0·91	0·054	5
11	8	1,110	1,350	1·63	0·052	4·5
17	9	1,070	1,335	—	0·042	4
18	9	1,070	1,335	1·56	0·050	3
22	9	1,060	1,340	—	0·046	4
25	9	1,060	1,340	—	0·044	3
Dec. 5	9	1,050	1,335	—	0·042	3·5
8	8	1,030	1,325	2·70	0·044	2·5
9	8	1,025	1,315	4·02	0·038	2·5
12	8	1,035	1,325	3·26	0·044	3·5
13	8	1,035	1,325	—	0·038	3
14	8	1,020	1,325	2·93	0·044	3·5
1939						
Jan. 4	8	1,030	1,335	2·93	0·038	3
5	8	—	—	—	0·040	3
6	8	1,050	1,340	—	0·042	3
Feb. 13	8	1,035	1,335	3·80	0·036	2·5
14	8	1,020	1,325	2·89	0·040	2·5
15	8	1,020	1,320	1·89	0·042	2·5
Mar. 14	8	1,015	1,335	2·09	0·038	3
15	8	1,015	1,335	2·38	—	3
16	8	1,015	1,335	1·16	—	3
Apl. 24	9	1,040	1,330	2·20	0·038	3
25	9	1,040	1,330	—	—	3
May 10	8	1,035	1,340	—	0·038	3
23	9	1,045	1,330	—	0·038	3
31	9	1,030	1,315	1·15	0·042	3
June 1-20	9-7	1,020	1,315	—	—	3
19	7	1,020	1,325	1·66	0·044	3·5
21-30	7	1,025	1,330	—	—	3-3·5
July 1-17	7	1,005	1,315	2·63	—	3
Aug. 1	7	1,020	1,305	2·42	—	3

and with low-temperature coke of the same grading. The tests were made in a 12 in. Metro grate by observation of a radiometer* situated at a distance of 3 ft. from the centre of the fire. Re-fuelling was carried out when the radiation had dropped to 200 B.Th.U. per sq.ft. per hr. All the samples were graded ¼ in. × 2 in.

TABLE 4.—*Grate Tests of Alkali Activated Coke compared with "Dryco" and Low-Temperature Coke*

Coke Sample	Volatile Matter, per cent	C.A.B.	Gas for Ignition cu. ft.	Time to Bright Fire, min.	Maximum Radiation, B.Th.U. per sq. ft. per hr.	
					1st period	2nd period
1	2	3	4	5	6	7
"Dryco" 1, Linacre	1·88	0·036	4	60	410	505
"Dryco" 2, Garston	3·17	—	4	70	385	495
Alkali activated coke, Garston	1·57	0·042	4	62	390	465
Low-temperature coke	7·4	0·028	4	66	387	420

These results indicate the similarity between "Dryco", alkali activated coke and a typical low-temperature coke.

EXPERIMENTS WITH OTHER COALS

It has already been stated that the main experiment was made with a Staffordshire coal. In addition, shorter tests have been made with other coals which have confirmed the effect of alkali activation in producing a satisfactory open grate coke from the ordinary gas coals used at Liverpool.

Two of these tests were made in the test retort at Athol Street Works and the results are given in Table 5.

In the experiment with the S. Yorkshire coal, the steam was reduced when alkali was added to nearly half the amount used when no alkali was added, with very little change in the calorific value of the gas. With the N. Wales coal the steam was practically unchanged in the tests with and without alkali, and in this case there was a drop in the calorific value of the gas compared with the test using alkali.

At the Garston Works a test was carried out for a week with a Lancashire coal, using the conditions previously described (throughput 8·3 tons per retort per day; temperatures 1,040° C. and 1,340° C.). With alkali addition the coke required 2·5 cu.ft. of gas for ignition.

TABLE 5.—*Results of Experiments with Other Coals*

Coal	Through-put, tons per day	Steam, per cent	Tempera-tures, ° C.		Per cent Alkali, $CaCO_3$, Na_2CO_3	Coke	
			Top	Bottom		C.A.B.	Gas for Ignition, cu. ft.
1	2	3	4	5	6	7	8
S. Yorkshire	6·97	21·5	1,010	1,340	nil	—	11
,,	7·08	21·1	1,010	1,340	nil	0·062	9
,,	6·62	22·7	1,010	1,340	nil	0·062	9
,,	6·85	12·1	1,000	1,340	2·4	0·044	3·5
,,	6·86	12·05	990	1,335	2·4	0·044	3·5
,,	6·67	15·95	990	1,330	2·4	0·044	3·5
N. Wales	7·02	21·6	1,020	1,345	nil	—	8
,,	7·24	21·1	1,020	1,350	nil	—	8
,,	7·47	19·5	990	1,320	2·4	—	3·5
,,	7·04	20·7	990	1,310	2·4	—	3·5

THE SALE OF ALKALI ACTIVATED COKE

It has been previously indicated in the Paper that the users of smokeless fuel in Liverpool have been encouraged to expect a relatively high combustibility in the fuel supplied by the Gas Company under the name of "Dryco". The C.A.B. of the fuel sold during a long period must have been of the order of 0·04; this method has only recently been used to determine reactivity and the quality has previously been maintained by measurement of "the ease of ignition" in a Metro grate and by grate tests. Considerable advertisement has not been used to develop the sale as it is obvious that the potential local demand is far greater than the ability of a Gas Undertaking to supply. The sales have increased as follows:

Year	"Dryco" sold, tons
1931	3,134
1932	7,391
1933	10,884
1934	15,645
1935	16,789
1936	18,250
1937	17,031
1938	16,758
1939	16,335

In the absence of a special sales drive the active market seems to be of the order of 16,000 to 20,000 tons per annum: the variations since 1936 are explained by variable weather, influx of cheap local coal and, in 1939, an increase in the price of "Dryco". Practically the whole of this quantity is burned in modern well grates, some of which are fitted with the usual boiler supplying the domestic hot water.

This is the market to which the alkali activated coke was delivered from the commencement of the operation of the process in October, 1938, until the retorts were shut down for inspection early in March, 1940. Approximately 6,000 tons have been supplied and the process was used to produce the basic quantity of "Dryco" at one Works throughout, variations in demand being met by increasing the output by the original method using selected coals. The fuel was made almost entirely from the Staffordshire coal and has very similar reactive properties to "Dryco".

During the period of the test the activated coke was delivered exclusively for considerable periods and at other times as a mixture with "Dryco" as circumstances required. During this time complaints which were received concerning the fuel were carefully analysed. They may be broadly divided into complaints of excessive ash and of poor reactivity. It was found that complaints due to ash were almost invariably caused by excessive amounts of shale in occasional deliveries of coal which had no connexion with alkali activation. Complaints of low reactivity were, in the majority of cases, traced to badly graded deliveries—excess of small sizes gives easy ignition with dull and low rate of burning, while excess of large sizes gives difficult ignition and free burning with coke of the same quality. These variations in size have been traced to segregation in the coke bunker. Occasionally, and particularly in the early stages, complaints of inactive coke have been traced to insufficient wetting of the coal before adding the alkali, with the result that there has been some segregation of alkali. As mentioned previously, after the introduction of two-stage heating there was a definite improvement in the reactivity of the coke, which confirms the generally accepted view that over-carbonizing must be avoided.

GAS AND BY-PRODUCTS YIELDS

A comprehensive programme of research on an isolated test retort was commenced during the summer of 1939, but

* The radiometer was of the Fuel Research Board type as modified by the Midland Coke Research Committee. This is described in "The Quality of Coke (The Second Report of the Midland Coke Research Committee)"; Mott, R. A., and Wheeler, R. V., 1939, p. 170 (Chapman and Hall, Limited).

was interrupted by the war, and it has not yet been possible to continue the work. This investigation was designed to determine the yields of gas and other products using "Dryco" coals under the "normal" and "Dryco" conditions of carbonization, and also the effect of adding alkali to the coals used for alkali activation.

The experiments are incomplete, and it is only possible to indicate the tendencies of the various conditions. The addition of alkali had no appreciable effect on the thermal yield with two of the normal gas coals under the carbonizing and steaming conditions used; in the third case, however, an increased yield of 4 therms per ton was noted. A point of importance in this connexion is the effect of alkali on the percentage of steam decomposed. On the large scale it has been definitely proved that a considerable increase in steam decomposition occurs in the presence of alkali and the same steam effect can be obtained with a much lower percentage of steam. The thermal yield obtained under "Dryco" conditions was about 8 therms per ton lower than is normally obtained, i.e., 72-73 compared with 80-81 therms per ton. It should be noted, however, that when "Dryco" is being made the quality of the gas is higher than would be the case if normal gas works routine were used and the carbonizing conditions were adjusted to produce gas of the desired quality. This is one of the factors which must be considered when coal is being carbonized primarily to obtain a predetermined quality in the coke, making the gas yield and quality of secondary importance.

The facilities available did not enable very accurate measurements of tar to be obtained but there does not appear to be any considerable difference in the presence of alkali with normal coals. There is a slightly higher yield of tar under "Dryco" conditions, due, presumably, to the lower temperature and reduced cracking of the tar vapours.

The addition of alkali gives an increased yield of ammonia and there is a small decrease in the sulphuretted hydrogen content of the crude gas.

COST OF GAS PRODUCTION UNDER "DRYCO" AND ALKALI ACTIVATED CONDITIONS OF CARBONIZATION

The ultimate success of the process described depends upon its effect on the cost of gas production. This is largely governed by the revenue obtained for residuals, and of these the product which yields the greatest proportion of the total is the coke. It is probably correct to say that the original Liverpool policy was the result of a poor coke market and it originated during a period when large stocks were accumulating and the only method available for disposal was by export at a low price. When the sales of "Dryco" developed there was certainly a considerable increase in the annual net realized price obtained for the coke and the price obtained for "Dryco" contributed largely to this. When a local domestic market is developed the sales become independent of industrial and trade market variations.

The estimated costs of gas manufacture by the various methods are shown in Table 6.

The lowest cost of gas production is obtained under alkali activation conditions The figures include the necessary adjustments for increased breeze production under alkali activated and "Dryco" conditions, and also the additional costs of cutting and screening which are not incurred with the sale of forked coke. In column 3 the cost of alkali and of the necessary admixing and anti-segregation plant is included, the total being 0·187 pence per therm (calculated on a basis of 2* per cent limestone, 0·5 per cent Na_2CO_3 + handling cost of 3d. per ton of coal treated). These costs are more than recovered in the greater revenue obtained for the coke.

TABLE 6.—*Costs of Gas in Pence per Therm ex Retort House*

Coal used	Staffordshire		Nottingham	
Conditions of Carbonization ...	Untreated	+ Alkali	Normal Works	"Dryco"
1	2	3	4	5
Dr.				
Coal	3·863	3·863	4·233	4·292
Producer Fuel	0·555	0·555	0·609	0·617
Alkali	nil	0·187	nil	nil
	4·418	4·605	4·842	4·909
Cr.				
Gross Coke	2·608	3·042	2·758	3·193
Tar	0·3	0·3	0·356	0·389
	2·908	3·342	3·114	3·582
Net Materials	1·510	1·263	1·728	1·327
Add Capital and Repairs ...	0·132	0·132	0·140	0·138
Retort House Labour ...	0·064	0·064	0·067	0·067
	1·706	1·459	1·935	1·532
Coal, tons per retort per day...	7·25	7·25	7·5	7·7
Therms per ton	80	80	73	72
,, ,, retort per day ...	580	580	547·5	554
Tar, gal. per ton coal ...	12	12	13	14
Coke, total cwt. per ton coal...	12·2	12	11·9	11·9
Breeze, per cent of total coke	10	20	12	23

The data emphasize the influence which the coke revenue has upon gas production costs and, with a local market immediately available, the Gas Undertaking can develop this by producing a domestic fuel properly graded and of consistent quality.

Some technicians have visualized the development of the domestic coke market to a greater extent than is required by local demands for gas. They suggest that coke sales should be increased to the point where the coal is carbonized primarily for the production of coke, and that the excess gas should be used for the heating of the retorts. This procedure will be necessary if, in the future, the burning of raw coal is to be greatly reduced. At present the carbonizing industries are completely unable to supply smokeless fuel in the quantity or quality which such a demand would require. In the meantime every effort should be made to improve the quality of the coke, thereby increasing the demand and reducing gas production costs.

EFFECT ON THE REFRACTORY MATERIALS OF THE RETORTS

The experiences of the Gas Industry of the effect of alkali upon refractory materials have invariably been the result of carbonizing coals containing sodium chloride, and the published results of numerous investigators have been concerned with this. As it was proposed to use sodium carbonate in a quantity rather less than the equivalent sodium chloride content of some coals, it was decided that the experiment was justified.

The process has been carried out in four upwardly-heated Woodall-Duckham vertical retorts in a setting of 16; there are available for comparison, therefore, retorts which have had a similar life and treatment without alkali. Prior to this experiment the setting had worked under normal conditions for 3½ years.

After operation for 17 months the jointing and brickwork of the retorts are generally in excellent condition, with the exception of two areas in each retort wall at the extremity of each major axis immediately above the sliding joint, and in the first few courses of the silica work. The erosion is greater on the inside and at these points has taken place over an area of probably 18 in. square and to a depth varying to a maximum of 1 in.; the firebrick courses immediately below are not affected. Similar areas of erosion are present in other retorts but to a very much smaller extent. Examination has been carried out under heat, and so far as can be observed there is no evidence of fusion at any point and the firebrick material both at the top and bottom is in very good condition. This erosion is in every case at the point of highest temperature in the retort and it is suggested in explanation that, owing to the increased reactivity of the coke, the zone of steaming is concentrated in a smaller run of retort than is the case with unreactive cokes, and the consequent increased local ash release is causing the greater ash erosion or corrosion or a combination of both.

After 12 months' working with alkali the retorts were inspected by a representative of the Woodall-Duckham Companies, who considered that they were in excellent condition and agreed with the suggestion that the erosion was the result of the concentration of the steaming zone. In order to overcome this difficulty the retorts were put on two-stage heating, provision for which is made in the setting; in this way the maximum local temperature is reduced and it is hoped that the steaming reaction has been spread over a greater length of coke travel.

The retorts have been inspected by representatives of the Refractory Materials Joint Committee of the Gas Research Board and the British Refractories Research Association, in order to obtain further expert opinion. These observations were made while the retorts were under fire, and it is hoped to have further information available as a result of a cold inspection.

* These quantities represent the maximum desirable alkali addition; 1·25 per cent limestone was used in the experiments described. A coal which required more than 2 per cent is unsuitable for alkali activation because of the resultant high ash content of the coke.

ACTIVATION OF COKE BY ALKALI AFTER CARBONIZATION

Difficulties were experienced in earlier attempts to activate coke, after carbonization, by treating with a solution of sodium carbonate. Chief among these has been the difficulty of controlling the amount of alkali added, and the invariable formation of a white surface when coke, dipped in a solution of sodium carbonate, is dried. Moreover, as it did not seem practicable to add lime after carbonizing, previous experience had indicated that the amount of sodium carbonate alone which would be required would probably be uneconomically high.

In the Research Department of Imperial Chemical Industries (Alkali) Limited, there has recently been carried out some work on the dust-proofing of coal and coke by treatment with a solution of calcium chloride. The normal technique for this treatment is to subject the fuel to a highly atomized spray of the solution. It occurred to the Authors that this technique might profitably be used for the addition of sodium carbonate to coke for the preparation of a reactive fuel for producer gas traction. For this purpose it did not seem likely that a white coke would be so disadvantageous as it would be for domestic use.

A number of experiments on spraying coke under various conditions have therefore been carried out, and it has been surprising to find that if certain conditions of treatment are observed the coke is not left covered with an objectionable white film of sodium carbonate. The coke absorbs the fine spray particles and is practically unchanged in appearance. The work on this subject is still very far from complete, but brief mention may here be made of some of the factors already established which it is hoped will provide the basis of a satisfactory process for the preparation of both domestic open grate coke and motor vehicle produced coke by treatment after carbonization. The most important factor appears to be that the coke surface must not be flooded with the solution so that a continuous film is formed over the external surface. If this occurs, a white coke is produced, but if the spray particles are sufficiently small and the rate of spraying is not too great the coke will absorb the spray continuously, and the amount of alkali which ultimately remains on the surface is only sufficient to cause a general lightening in the normal grey colour of the coke, with perhaps occasional white areas where some shale or less absorbent coke particles have been unable to take up the solution. An important point is that the penetration of the alkali into the coke when treated in this manner leaves no loose surface film of alkali which can be lost or can be a nuisance in subsequent handling. It is possible that the reason a white external surface film is formed when coke is dipped or is sprayed too rapidly may be that the pores of the coke are covered with liquid and become air locked, thus preventing further penetration of the solution.

The most satisfactory results have been obtained when the coke particles are moving in the spray mist, thus presenting continuously changing surfaces to the impingement of the spray. This decreases the chance of flooding any particular portion of the surface. It has also been found advantageous to spray coke when it is hot. This brings into operation the suction effect due to the cooling of the coke and allows the spraying time to be decreased, and also probably allows greater penetration of the solution. It has the further advantage of drying off the greater part of the water added in the spraying process. In the small-scale experiments use has been made of a rotating drum with small lifting flanges in which the coke particles are continually rolling over on themselves, and spray nozzles are fixed on a pipe along the axis of the drum. In this apparatus, with coke heated to about 150° C. and a spraying time of 1 to 2 min., 1½ and 2 per cent of sodium carbonate have been added, and the coke scarcely differs in appearance from ordinary coke. A rotary louvre drier has recently been converted to provide a continuous process. The coke is fed at one end and heated by flue gas in the first portion of the drum and sprayed in the remainder. The temperature of the coke and the rate of spraying can be suitably adjusted to the rate of coke feed to give the desired amount of alkali impregnation. The preliminary results obtained have been very promising.

These experiments have so far been carried out in the laboratory. In the Works it should, in many cases, be possible to treat the graded coke passed directly from the vertical retorts through a crushing and screening plant. Under these circumstances the coke would probably retain sufficient heat to be sprayed directly, without the necessity of reheating.

The Authors have, so far, had more experience in the spray treatment of coke graded suitably for producer gas traction, e.g., ¼ in. × ⅜ in., than with domestic gradings. The treatment of domestic gradings requires more careful control of conditions, as the external coke surface presented to the spray is so much smaller and therefore more easily flooded and whitened. The small-scale results have been sufficiently promising, however, to give some confidence in the possibility of preparing alkali activated coke in this way on the large scale.

The results have so far indicated that by the addition of 1½ to 2 per cent of sodium carbonate the reactivity is brought to the same level as by the pre-carbonizing treatment described earlier in this Paper. This quantity of alkali is less than the amount which has generally been regarded as necessary when sodium carbonate alone is used. Most experiments on the quantity of alkali required have been made by addition of alkali before carbonizing, and under these conditions the alkali is probably more exposed to the effect of the ash, which has already been described. When alkali is added after carbonizing, the ash can only combine with it during combustion and the alkali is apparently able to exert its activating function before it reacts with the ash.

It is appreciated that there is a great deal more work to be done before this method of applying alkali activation can be regarded as completely established, and, in attempting to transfer it to full works scale there will undoubtedly be further difficulties to overcome. But it is felt that the advantages of an alternative method of applying alkali activation which avoids any possibility of damage to retort refractories, however slight, are sufficiently great to justify the presentation of these preliminary results for discussion. It is too early in the investigation to make any detailed estimate of the cost of the spray treatment. But assuming an alkali addition of 1½ to 2 per cent sodium carbonate is required, and that there is about 25 per cent breeze formation in preparing graded domestic coke, the cost should be approximately the same as for the pre-carbonization treatment.

THE PREPARATION OF REACTIVE COKE FOR PRODUCER GAS TRACTION

Some time ago an investigation was made by the London and Counties Coke Association of the suitability of reactive gas cokes for producer gas traction, and among the cokes examined were "Dryco" and alkali activated coke, both of which have a C.A.B. value of about 0·040. The tests were made in a cross-draught type of producer using a dry blast. These cokes were found to be unsuitable. Their reactivity was insufficient to give a good gas, and owing to the high temperatures reached in the producers a lot of clinker was formed. It then occurred to the Authors that if alkali was added to "Dryco" a considerable improvement in reactivity should be obtained. Lime and sodium carbonate were added to a "Dryco" coal carbonized in the vertical test retort at the Athol Street Works under the "Dryco" conditions described earlier in this Paper, and a coke was obtained with a C.A.B. of 0·024. When this was tested in the same producer a much more satisfactory result was obtained. Good gas was obtained 4 min. after lighting, a result comparable with that obtained with anthracite, and a satisfactory test run was made over a distance of about 90 miles. No trouble due to clinkering was experienced. This performance, though by no means a comprehensive test, opened up a promising line of development for producer traction fuels which has been pursued since the war.

The Mining Association of Great Britain has published a provisional specification for producer fuels in which the important items for carbonized fuels are (i) the C.A.B. shall not exceed 0·030, (ii) the tar content shall not exceed 0·03 per cent, (iii) the ash content shall not exceed 6 per cent (with a tolerance of 1 per cent). The coke prepared by alkali addition to "Dryco" satisfied this specification. The first samples were prepared, as mentioned above, by the addition of the alkali before carbonizing. More recently the producer fuel has been prepared by the spray impregnation method. Producer trials which have been made by the British Coal Utilisation Research Association, by Vauxhall Motors Limited and others have shown that "Dryco" to which 1·5 per cent Na_2CO_3 has been added will make gas virtually identical in composition and calorific value with that obtained from good quality low-temperature cokes already recognized as among the best producer fuels available in this country.

It appears that the fuel is particularly suitable when steam is used, as the remarkable reactivity of the coke to steam enables a rich producer gas to be made containing a high percentage of hydrogen. The addition of steam also appears to have a considerable advantage compared with a dry blast in reducing the temperature of the fuel bed and thereby

reducing the possibility of clinker formation. This is of particular importance in using cokes which contain 6 or 7 per cent of ash.

It is not proposed to discuss here the advantages or disadvantages of producer gas for motor vehicles. If, however, producer gas traction can make a contribution to war-time oil economy, or can find a place for itself in peace-time on grounds of saving in fuel costs, then it is suggested that the method of fuel preparation outlined merits the consideration of the Gas Industry.

The coals used for "Dryco" manufacture have been described as medium coking, practically non-swelling. It is tentatively suggested that the basis for selection may be more broadly stated to include coals with a dry, ashless carbon content of 81·5 per cent to 83 per cent. If coals of this rank are carbonized in vertical retorts with care taken to avoid over-carbonizing, it should generally be possible to obtain a coke with a C.A.B. of 0·045 or less and a tar content not greater than 0·03 per cent. The Authors have recently carbonized some coals selected on this basis, and have so far had no difficulty in obtaining coke with the required properties after suitable adjustment of the retort throughput to allow for the varying swelling characteristics. The addition of alkali to these cokes by spraying will then increase the reactivity to the equivalent of a C.A.B. of 0·030 or less. Although coals of this rank are normally carbonized by some Gas Undertakings on account of proximity to the coal-fields producing them, to many Undertakings their use would represent a decreased thermal yield compared with the more usual gas coals of higher rank. Taking the Liverpool Gas Company's experience as a basis, where the thermal loss would be about 8 therms per ton, it is estimated that the thermal loss and the alkali treatment are equivalent to an increased coke cost of approximately 3·6 s. per ton of coke. This is the increased price that would have to be realized for the coke to prevent a rise in the cost of gas production.

Although this Paper is primarily concerned with the problem of increasing the reactivity of coke, it will not be out of place in this consideration of producer traction fuels to mention the question of grading. For most types of vehicle producer which have been developed, and particularly for the cross-draught type, it is generally considered that a fairly close fuel grading is required. A fairly common grading chosen is ¼ in. by ⅛ in. The normal method of free crushing applied to the preparation of these gradings will give a high yield of undersized material. This will not only decrease output but will greatly increase the cost of the fuel. In this connexion, attention is drawn to a method of crushing, recently published,* which has been shown to give high yields of closely-graded material. If this type of crushing can be developed it should provide the solution to the economic production of close-graded producer fuels.

An alternative which is particularly attractive is the development of a design of producer able to use a fuel of wider grading, which could economically be made with existing types of crusher. Considerable progress has been made in this direction by the British Coal Utilisation Research Association.

* Carey, W. F., Proc.Inst.Mech.Eng., 1939, 141,563.

SOUTH EASTERN GAS CORPORATION BILL

THIS Bill, which is unique in that it is promoted by a Holding Company for the purpose of obtaining powers for the Companies which it controls, came before a Select Committee of the House of Lords on Monday, June 3. The Committee consisted of Lord Macmillan (Chairman), Lord Listowel, Lord Belstead, Lord Swinfen, and Viscount Buckmaster. Counsel for the promoters were Mr. Sydney Turner, K.C., and Mr. H. Cope Morgan. The Bill was unopposed, but owing to the novel proposals in it, the Lord Chairman of Committees had reported to the House, under the Standing Orders, that owing to the nature of the proposals, it should be referred to a Select Committee for consideration as if it were an opposed Bill.

Mr. Sydney Turner, K.C., for the promoters said that although the Bill was promoted by the South Eastern Gas Corporation, all the powers which it was proposed to confer by the Bill were to be conferred upon other companies which were subsidiaries of the Corporation. He went on to explain that the Corporation controlled 29 companies by the holding of shares but the Bill was only concerned with 24 of them, of which 20 companies were statutory companies and four were non-statutory. In 21 of the 24 companies, the South Eastern Gas Corporation held more than 75% of the total issue of stock or shares.

Commenting on the Report of the Lord Chairman of Committees, Mr. Turner explained to the Committee that this Report drew attention to the fact that the South Eastern Gas Corporation was incorporated under the Companies Acts and had no statutory powers but now sought to obtain powers which were ordinarily granted to gas companies, on behalf of the companies which it controlled. The Report stressed the fact that this was a novel procedure in Parliamentary Bill promotions, and the effect would be that the individual companies would be granted additional powers without its being necessary for the individual companies to comply with the Standing Orders of Parliament relating to the submission of the Bill to the shareholders and obtaining a three-quarters majority in favour, which would be necessary if each of the companies promoted its own Bill.

The Report of the Lord Chairman then pointed out that the most important proposal of the Bill was to confer powers on the various companies to raise new capital and to increase the proportion of loan to share capital. In addition, certain other powers of an administrative character were asked for on behalf of the companies. It was added that the advantage of this type of legislation was that there would be a great saving of expense as compared with the promotion of 24 separate Bills and that in some cases the companies were so small that the cost of promoting a Bill would be prohibitive.

The Chairman said that under this novel procedure, it would be possible that individual shareholders would not know anything about what was going on in Parliament affecting their rights inasmuch as there would be no obligation on the individual companies to call a meeting of their shareholders to discuss a Bill promoted by the South Eastern Gas Corporation.

Mr. Sydney Turner replied that that was true but reminded the Chairman that arrangements had been made for calling meetings of all the companies concerned in this case. He suggested, too, that this matter should not be treated as one of principle but as a question to be determined on the merits of each case after considering such matters as the relationship between the promoting company and the subsidiary companies, and the nature of the provisions in the Bill.

The Chairman suggested that provision had to be made not for the good people but for the bad people.

Mr. Turner agreed, but added that it was also for distinguishing between the good and the bad.

Continuing, he referred to the Lord Chairman's remark that a promotion such as this led to the saving of a great deal of expense, and said that that was specially important at the present moment.

The Chairman said it would be conceded that if the individual companies had promoted separate Bills for the powers now proposed, they would have been quite innocuous inasmuch as the proposals were common form gas Bill proposals. The only point was whether the Bill modified in any way the Parliamentary practice so far as the individual companies were concerned.

Mr. Turner said he was not so much concerned with the question of principle. He wanted to justify this Bill in the circumstances of this particular case.

The Chairman said it might well be that Parliament in an emergency would sanction a short cut in a particular case, without pledging itself to the procedure being a precedent.

Mr. Turner said his argument was that if the Committee allowed this Bill to proceed, it could not be treated as a precedent because it would be a decision given in the circumstances of the case.

The Chairman remarked that the question of principle was not so much whether the change was radical but rather whether the individual shareholder was deprived of the right to judge for himself whether the change proposed was desirable.

Mr. Turner said that Sir David Milne Watson was Chairman of 23 out of the 24 companies and, as he had said, in most of the companies, the South Eastern Gas Corporation held the vast majority of shares. Nevertheless, notices had been given for the necessary Wharnecliffe meetings to be held during the coming week, so that the shareholders of each of the 24 companies would have an opportunity of expressing their views.

The Chairman replied that that was very important, and asked for a formal undertaking on the part of the promoters that such meetings would be held.

Mr. Turner, for the promoters, readily gave that undertaking.

Commenting on the Report of the Board of Trade on this Bill, Mr. Turner drew attention to the statement that the Board appreciated that this method of procedure would be to the advantage of the consumers and shareholders, although stress was laid on the fact that it was a novel procedure and should be examined carefully.

The Chairman asked what was the justification for the increased capital powers asked for.

Mr. Turner said it was largely for plant and mains extensions and was also related to the increased costs of plant, mains, &c., in present circumstances.

Sir David Milne-Watson gave evidence confirming what Mr. Turner had said to the Committee. Speaking of applying to the Board of Trade for some of these powers, he said the Board was not able, owing to the exigencies of the circumstances, to give attention to these matters without considerable delay; and as the demands of munition works, A.R.P., &c., called for immediate extensions, this work simply could not be done unless permission to raise the necessary money was given at once. There was also the need for benzole plants at the present time and without the necessary capital powers, these works could not be carried out.

The CHAIRMAN told Sir David that the reason why the Committee was sitting was because of the novelty of the proposals in the Bill. The expediency of the proposals seemed to be generally accepted and he enquired whether Sir David put them forward because of the present national emergency.

Sir DAVID MILNE-WATSON said that was so. In times like these, apart from all other considerations, there should not be the necessity for 24 Bills.

The CHAIRMAN said he also understood that methods which were normally available for obtaining some of these powers through the Board of Trade were not available at the present moment without considerable delay.

Sir DAVID MILNE-WATSON replied in the affirmative and, later, he repeated the assurance given by Mr. Sydney Turner that Wharnecliffe meetings of shareholders of all the constituent companies would be held.

The Committee Room was then cleared.

The CHAIRMAN subsequently announced that their Lordships, having regard to the present national emergency and to the statement by the promoters that before the Bill became law, meetings of the 24 companies affected had been or would be held in each case, as if the provisions as to holding Wharnecliffe meetings applied, and having regard also to the special financial position of the promoting company relatively to the 24 companies concerned, were prepared to report that in their opinion the Bill should be allowed to proceed.

Company Meeting

ASSOCIATED GAS AND WATER UNDERTAKINGS, LTD.

The Seventh Ordinary General Meeting of Associated Gas and Water Undertakings, Ltd., was held on May 29, 1940, at Incorporated Accountants' Hall, Victoria Embankment, London

Mr. W. H. BENNETT, M.Inst.Gas E., the Chairman of the Company, said: The balance-sheet shows that the issued share capital has increased during the year to £3,329,799. The increase of £97,948 is due to the acquisition of three further gas undertakings, to which I will refer later.

You will observe a new item—namely, "Reserve for Taxation." In view of the war and the prospect of further heavy burdens in taxation, your Directors have deemed it advisable to set aside £4,000 to meet this contingency. This reserve purports to cover excess profits tax, the Company's liability to which, if any, it is at present impossible to determine.

The assets side of the balance-sheet shows that investments now stand at £2,960,176, an increase of £86,142 during the year. This total is arrived at after writing off the sum of £3,089, largely representing stamp duty incurred on the acquisition of the three new undertakings.

Further freehold land and buildings have been acquired, and this asset now stands in the books at £43,633, an increase of £16,473 since last year.

Revenue Account

Regarding the revenue account, it is satisfactory to note that dividends on investments at £117,601 have increased by £9,126, due to the further undertakings acquired. All other sources of revenue show satisfactory increases.

As to expenditure, interest on debenture stock shows an increase of £4,375, due to a full year's interest on the additional £250,000 of debenture stock issued during 1938. Against this item may be offset the decrease in bank interest and charges, amounting to £2,440. Having regard to the increased scope of the Company's operations, the other figures of expenditure may be considered normal.

The final result of the year's working is that the accounts show, after provision for income tax, a net profit of £74,574, permitting the payment of a dividend at the rate maintained since the inception of the Company six years ago. Accordingly your Directors have pleasure in recommending a dividend on the Ordinary capital of 5% per annum. If this recommendation is approved, the undivided profit to be carried forward will be £32,551, an increase of £9,791 over that of 12 months ago.

Further Acquisitions

The three gas undertakings acquired during the year are situated in our Western Group. Two—those at Minehead and Clevedon—are in close proximity to our three other companies in Somerset. The Dartmouth undertaking increased the number of companies controlled by us in Devon to four, bringing the subsidiaries in the West of England to nine. Our other group of public utilities remains at 16, making the total number of associated undertakings 25.

Although negotiations for the acquisition of undertakings continued during the period preceding the outbreak of hostilities, the war has suspended further expansion. Apart from the Treasury restrictions on capital operations, the country is concentrating the whole of its resources and energy on the prosecution of the war. Desirable though further grouping of public utilities may be, it is impracticable, as far as can be seen at present, for this movement to extend until the general situation and the financial position return to more normal conditions.

The war has, however, served to emphasize the benefits which accrue to public utilities associated under our ægis. Material though the advantages may be in ordinary times, the co-ordination of the operation of such utilities in the present unprecedented conditions has proved of inestimable value to Associated Undertakings and to the public whom they serve

Increased Output Despite War

The business done by our undertakings during the year 1939 has increased in every direction save in the sale of gas appliances and fittings. This decline is to be attributed to the national and individual need of economy, reduced spending power, and the general state of uncertainty brought about by the war.

In the more vulnerable areas throughout the country these conditions have further resulted in a substantial decline in the sales of gas, coke, and by-products, but Associated Undertakings have not suffered in this respect. Situated in urban and rural areas, largely residential, throughout Southern England, they are in normal times less affected than many other districts by industrial depression and artificial trade expansion, while under war conditions they enjoy the advantages of being "reception areas."

Accessions to the population from persons and business houses evacuated from towns in the danger zones resulted in our companies experiencing enhanced sales of gas, electricity, coke, and by-products and increases in the number of consumers. This was achieved despite the introduction of gas rationing, subsequently suspended, and was not due to abnormal weather conditions, which occurred after the termination of the year covered by the statistical summaries of our undertakings. The number of gas consumers increased during 1939 by 3,766 to 132,827, who are supplied through 1,693 miles of main in authorized areas of supply totalling 1,410 square miles. Gas sold has risen to 3,202 million cu.ft.

A similarly satisfactory position is to be observed among our undertakings which supply electricity as well as gas. The numbers of electricity consumers and of appliances and fittings sold have increased, while the sale of electricity has risen by 10%. In addition, the electricity plant, equipment and mains of these undertakings have been maintained at a high state of efficiency and extended to meet the growing demand.

Difficulties Ahead

While the Gas Industry may be said to have met the war situation satisfactorily until now, the difficulties of the immediate future are formidable, and no useful purpose would be served by ignoring the task which lies ahead.

Apart from the perils of war, gas undertakings have to face serious rises in the cost of coal and other materials and, in addition increases in wages and non-remunerative expenditure necessitated by civil defence. It is not generally realized, for example, that the present cost of sea-borne coal delivered to an undertaking in the South of England represents an increase of the order of 33⅓% over the pre-war price.

These increases are unavoidable. The additional burden, however, as a matter of business and goodwill, cannot be passed on in its entirety to consumers. In any event the Gas Industry has for long been subject to statutory control and inevitably this has increased since war commenced.

The principal element in such control is that the dividend, in "sliding scale" companies, must fall as the charge for gas rises and vice versa. Increases to-day in the price of gas are unavoidable, with the result that dividends payable by such companies would automatically be reduced to a level constituting real hardship to the gas investor. The Government, however, has met the situation to some extent by providing a measure of relief for undertakings with a declining gas output and for those whose net cost of coal and oil has increased. Increases due to wages and materials other than coal and oil are not taken into account, and no relief is given in so far as the dividend as determined by the Company's statutory provisions declines by 1% or less.

Co-operation and understanding on the part of all concerned are essential if the interests of consumers and shareholders are to be dealt with fairly. In particular it is essential that the reconciliation between the costs of production and the selling prices of gas and coke should be equitable and expeditious. Fortunately it is generally realized that, in addition to the public service which the Gas Industry performs in maintaining the supply of a fuel capable of economic utilization, the by-products of gas manufacture comprise innumerable materials essential to the prosecution of the grim struggle in which the country is engaged.

Officers and Staff

The officers and staff at head office and in our associated undertakings may well take pride in the satisfactory results achieved during the exceptional conditions of the year under review.

In thanking and paying tribute to them on your behalf I know that during the struggle which lies ahead we can rely upon them to add to their ability and enthusiasm of the past that fortitude and energy which will be necessary to ensure the maintenance of our service in the common cause.

The report and accounts were unanimously adopted, and the proceedings terminated with a hearty vote of thanks to the Chairman, Directors, and staff.

South Suburban Gas Company's Bill

THE Bill promoted by the South Suburban Gas Company was considered by the Unopposed Bills Committee of the House of Commons on May 30. Colonel Clifton Brown (Chairman of Ways and Means) presided.

The Bill, which contains a variety of provisions of a miscellaneous character, has already passed the House of Lords.

Mr. A. B. WINSER (Messrs. Sherwood & Co., Parliamentary Agents) said that one of the clauses, upon which the Board of Trade had commented, was to give the Company power to carry pipes across corners of contiguous supply areas where that course was shorter and more convenient than a course which was wholly within the Company's area. The clause would not enable the Company to supply gas in such a contiguous area.

Another clause in the Bill relieved the Company from the necessity of serving individual notices to consumers when the declared calorific value of the gas supplied was to be varied, and reduced the period of notice necessary before making an alteration. When the Bill was in the House of Lords, the clause was contested by local authorities; the Committee of the House of Lords which had dealt with the Bill had agreed to relieve the Company of the necessity for serving individual notices, but had permitted the reduction of the period of notice only during the war. The clause had been amended accordingly.

A clause which was designed to give the Company freedom to issue capital, whether by public subscription or privately, in such manner as it thought fit, was contested in the House of Lords by the local authorities, and the decision of the House of Lords Committee was that any such issues should be subject to the approval of the Board of Trade. Effect was given to that decision by adding the words "with the approval of the Board of Trade, to be signified in writing under the hand of an Assistant Secretary of that Board." A report from the Board of Trade, however, stated that the clause would appear to impose upon the Board the duty of deciding whether or not the Gas Company should be allowed to issue stock otherwise than under the auction provisions, but without giving the Board power to control the price, terms, conditions, or manner of issue. The Board urged that it should not be given the duty of approval without the power to control the price, terms, conditions, and manner of issue, in view of the fact that, by Section 1 of the Gas Undertakings Act, 1934, the Board had power to authorize undertakers to offer stock by subscription by the public as an alternative to public auction, subject to such conditions as they thought fit to impose, and had made the price of issue an important point.

It might be, said Mr. Winser, that on the interpretation which the Board of Trade placed on the wording of the Clause, it was not clear whether they would be able to withhold approval. The Gas Company raised no objection to the Board of Trade controlling the terms of issue. The Committee might desire to improve the wording. The Company did not wish to be uncertain as to the position. If the Board of Trade were to control an issue, he would ask the Committee to eliminate some of the restrictions mentioned in the clause, in order to avoid duplication.

The CHAIRMAN said the Committee felt that the approval of the Board of Trade covered everything, and that there was no reason to alter the wording.

Mr. WINSER, dealing with another clause, which provided that the Company should promote another Bill in 1945 to give the local authorities the opportunity to make observations before Parliament concerning the Company's basic price, said that originally the clause asked for the promotion of the next compulsory Bill in 1950, but, in order to meet objections raised by the London County Council and possibly other authorities, the period was reduced to five years—*i.e.*, 1945. The Board of Trade had drawn attention to a recommendation of the Joint Committee of the Houses of Lords and Commons on Gas Prices, that local authorities could at any time make application to the Board of Trade for revision of basic price. That recommendation, however, was one of several, and none of them had yet been acted upon in general legislation; he urged that the Company should not be asked to agree to only one of the recommendations of the Joint Committee. Normally the basic price was subject to revision by Parliament only, and that was the object of inserting the clause requiring the Company to promote a Bill within a limited time.

The Committee decided that the clause should not be altered, and the Bill was ordered to be reported for third reading.

The Bulk Supply of Gas which Mansfield receives from the Grassmoor Colliery Company is the subject of negotiations which have been proceeding recently between the Colliery Company and the Corporation. The Company asked for an increase in the price of gas they supplied to Mansfield having regard to the wartime rise in the costs of production. They also asked the Corporation to consider working the water gas plant at Mansfield, if called upon to do so, to help the Company to supply more gas to another local authority for work of national importance, with an offer to reimburse the Corporation for the extra cost involved. The Corporation have agreed to make an *ex-gratia* payment to the Company for the year ending March 31 next, equivalent to an increase of 5% on the account due to the Company at the end of that period. The Gas Engineer has been instructed to confer with the Company on the working of the stand-by plant. He has reported to the Gas Committee that the plant could be brought into commission to give a supply for short periods, but the repairs, estimated to cost £870, would be needed to the water gas holder to give a constant supply.

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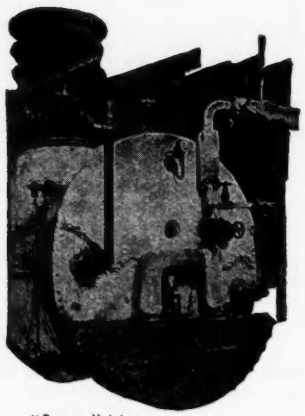

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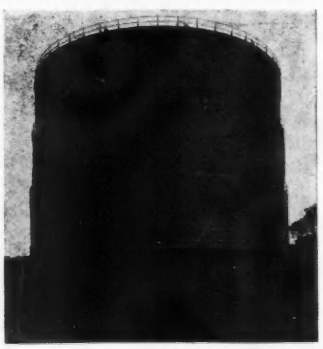

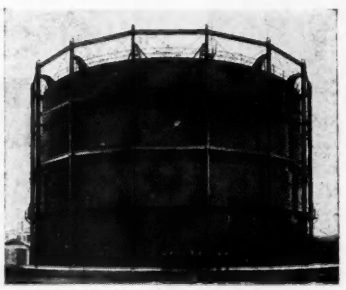

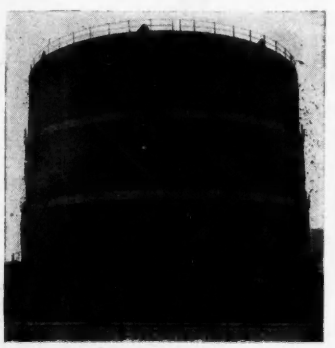

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Sales of Gas Products

The London Market

June 10.

There are no alterations to record in the values of tar products in the London market, which are as follows: Pitch about 50s. per ton f.o.b.; creosote, about 4¼d. to 5d. per gallon; refined tar, 3¾d. to 4d. per gallon; the price of pure toluole under the Ministry of Supply order is just under 2s. 5d. per gallon; pure benzole, 1s. 10d.; 95/160 solvent naphtha, 1s. 11d. to 2s., and 90/160 pyridine about 18s. 6d., all per gallon naked; refined naphthalene crystals, £23 per ton in bags, all *ex* makers' works.

The Provinces

June 10.

Crude Gas-Works tar, 27s. 3d. to 32s. 3d.

To avoid misunderstanding, it is necessary to state that the above price is not claimed to represent a market value. It is a price worked out from week to week upon a system which has been used for many years as a basis for the fixing of certain contracts for crude tar of varying qualities in different areas.

The average prices of gas-works products during the week were: Pitch—East Coast, 47s. 6d. to 52s. 6d. f.o.b. West Coast—Manchester, Liverpool, Clyde, 47s. 6d. to 52s. 6d.* Toluole, naked, North, 1s. 9½d. (Controlled by the Ministry of Supply Order No. 1, which fixes the maximum price at which this material may be sold). Coal tar, crude naphtha, in bulk, North, 9d. to 9½d. Solvent naphtha, naked, North, 1s. 8d. to 1s. 9d. Heavy naphtha, North, 1s. 4½d. to 1s. 5½d. Creosote, *ex* works, in bulk, North, liquid and salty, 4½d. to 4¾d.; Scotland, 4¼d. to 4½d.; low gravity, 4½d. to 4¾d. Fuel Grade, 4d. to 4¼d. Carbolic acid, 60's, 3s. 6d. to 3s. 7½d. Naphthalene, £15 to £20. Salts, 75s. to 85s., bags included. Anthracene, "A" quality, 4¼d. to 4¾d. per minimum 40% purely nominal. Heavy oil: Unfiltered anthracene oil, (min. gr. 1,080), 5¼d. to 5½d.; filtered heavy oil (min. gr. 1,080), 5¾d. to 6d.; heavy anthracene oil gr. less than 1,080, 6d. to 6¼d.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls, whatever they may be.

Scotland

GLASGOW, June 8.

Deliveries against contract are proceeding smoothly and new business is on a moderate scale. Values of all products are well maintained.

Crude gas-works tar.—The actual value is about 42s. 6d. to 45s. per ton *ex* works in bulk.

Pitch is well looked after with prices of vertical quality unchanged at about 40s. per ton f.o.b. for export and about 37s. 6d. per ton *ex* works in bulk for home trade.

Refined tar.—Demand is limited, but home price is fixed at 4¼d. to 4½d. per gallon. Supplies for export are now quoted at 3½d. per gallon, both f.o.r. naked.

Creosote oil.—Production is well able to look after demand and quotations are as under: Specification oil, 5½d. to 5¾d. per gallon; low gravity, 6½d. to 7d. per gallon; neutral oil, 6d. to 6½d. per gallon; all *ex* works in bulk.

Cresylic acid.—There is little or no fresh business being placed but prices show no alteration as follows: Pale, 97/99%, 2s. 1d. to 2s. 2d. per gallon; dark, 97/99%, 1s. 10d. to 1s. 11d. per gallon; pale, 99/100%, 2s. 6d. to 2s. 8d. per gallon; all *ex* works in buyers' packages.

Crude naphtha continues to change hands as available at 6½d. to 7½d. per gallon, *ex* works in bulk, according to quality.

Solvent naphtha.—90/160 grade is 1s. 8½d. to 1s. 9½d. per gallon and 90/190 heavy naphtha is 1s. 4½d. to 1s. 5½d. per gallon.

Motor benzole is 1s. 8d. to 1s. 8½d. per gallon.

Pyridine.—Prices are nominal at 18s. to 19s. per gallon for 90/160 grade and 20s. to 21s. per gallon for 90/140 grade.

Company Meetings

Consett Iron Co.

Consett Iron Company, whose financial year ended on March 31, has had urgent demands for all its products. Gross profit rose from £669,717 to £1,061,188. Naturally, taxation absorbed a large proportion of the increased earnings, this provision rising by £308,000 to £428,000. After providing for taxation, debenture interest, and depreciation at the usual rate of £125,000, net profit for the year showed an increase of £87,585 at £440,352.

The 7½% dividend which is again being paid is conservative having regard to these earnings, for it has again been possible to add £100,000 to the reserve for the improvement of plant; £23,000, against nil, has been employed in writing down investments; and the allocation to redemption of the 4½% redemption stock has been increased from £32,600 to £53,010.

Goodlass Wall & Lead Industries, Ltd.

At the ninth annual general meeting of Goodlass Wall & Lead Industries, Ltd., the Chairman (Mr. Clive Cookson) said that on the lead side their business up to the outbreak of war had followed a very similar course to that of 1938. Very different conditions in various departments had, however, been introduced by the war. Some had been stimulated, but others, notably those connected with the building trade, showed a considerable falling off. Exports during the first months of war had been very active, but, when all those factors had been balanced up, the lead side of the Company's business had shown no great change in volume from that of the previous year. On the paint side the net result of the fluctuations had been a satisfactory increase in turnover reflected in improved financial results.

The trading profit was £267,719 against £275,416. If the dividend recommended of 6%, with a bonus of 1%, was approved they would carry forward £79,321.

Trading Results

Peter Brotherhood.—12% making 20% (24%).

R. & A. Lister.—Interim 5% (same).

Whessoe Foundry & Eng.—40% (same): reserve nil (general reserve, £25,000).

Contracts Advertised

Benzole Recovery Plant.
Greenock Gas Department. [p. 598].

Oxide of Iron.
Warrington Gas Department. [p. 598].

Mechanical Shovel and Loader.
Warrington Gas Department. [p. 598].

A.R.P.

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GAS STOCKS AND SHARES

Since everyone's thoughts and energies are now directed towards the country's war effort, business on the Stock Exchange has reached very small proportions. Last week it was only in the gilt-edged section and among a few leading industrials that any activity took place. British Funds did not wholly maintain their previous week's levels and a few closed fractionally lower—2½% Consols finished at 72½ xd. against 74 at the opening. In contrast to the former heavy falls in home rails several of the fixed-interest stocks in this section closed higher. Important announcements by the Chancellor of the Exchequer during the week were the raising of the Excess Profits Tax to 100% and the subsequent cancellation of the Limitation of Dividends Bill.

As elsewhere, the volume of business in the Gas Market was again very limited, and a further number of reactions in prices took place although with few exceptions those stocks marked down a week ago maintained their levels. The margin of Gas Light units narrowed to 1s., showing a small drop of 3d., South Metropolitan declined a further 3 points to 54½ and at this price the yield on a 4½% dividend basis is a high one at 8¼%. South Eastern and United Kingdom ordinary shares were both marked down, and it will be seen in the list below that a number of preference and debenture issues also weakened, the latter including another drop of 5 points in Imperial Continental 3% debenture. On the Provincial Exchanges, Bristol, Newcastle, and Sheffield ordinary stocks reacted, though it will be noticed that the value of a number of fixed-interest stocks in these lists are quoted at prices considerably higher than similar class issues on the London Exchange. The Supplementary List again remained unchanged.

Official Quotations on the London Stock Exchange

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations June 7.	Rise or Fall on Week.
1,767,439	Mch. 11	8	7	Alliance & Dublin Ord. ...	110—115	−2
374,000	Dec. 27	4	4	Do. 4 p.c. Deb. ...	80—90	...
957,608	May 13	5	5	Assocd. Gas & Water U'd'cts Ord.	14/—16/-	...
500,000	,,	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	15/6—17/6	...
535,545	,,	4	4	Do. 4 p.c. Red. Cum. Pref.	14/6—16/6	...
336,646	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	13/—15/-	...
750,000	Mch. 18	3½	3½	Do. 3½ p.c. Red. Deb. ...	82—87	...
560,070	Feb. 19	7	7	Barnet Ord. 7 p.c.	122—127	...
300,000	Apl. 8	1/4⅝	1/9⅜	Bombay, Ltd.	19/6—21/6	...
181,915	Feb. 26	9½	9½	Bournemouth Sliding Scale ...	145—150	...
690,526	,,	7	7	Do. 7 p.c. max. ...	118—123	...
493,960	,,	6	6	Do. 6 p.c. Pref. ...	116—121	...
50,000	Dec. 18	3	3	Do. 3 p.c. Deb. ...	70—75	...
362,025	,,	4	4	Do. 4 p.c. Deb. ...	95—100	...
335,000	,,	5	5	Do. 5 p.c. Deb. ...	102—107	−3
357,900	Feb. 19	7½	6¾	Brighton, &c., 6 p.c. Con. ...	103—108	...
659,955	,,	6¾	5⅝	Do. 5 p.c. Con. ...	100—105	...
205,500	,,	6	6	Do. 6 p.c. 'B' Pref. ...	103—108	...
855,000	Mch. 11	7	8	British Ord.	90—100	...
100,000	Dec. 18	7	7	Do. 7 p.c. Pref.	120—125	...
350,000	,,	5½	5½	Do. 5½ p.c. 'B' Cum. Pref.	110—115	...
120,000	,,	4	4	Do. 4 p.c. Red. Deb.	77—82	...
450,000	,,	5	5	Do. 5 p.c. Red. Deb.	100—105	...
100,000	22 May '33	6	4	Cape Town, Ltd.	½—¾	...
100,000	6 Nov. '33	4½	4½	Do. 4½ p.c. Pref.	½—¾	...
150,000	Dec. 18	4½	4½	Do. 4½ p.c. Deb.	53—58	...
626,860	Jan. 29	6	5⅞	Cardiff Con. Ord.	103—108	...
237,860	Dec. 18	5	5	Do. 5 p.c. Red. Deb. ...	95—100	...
98,936	Apl. 8	2/-	2/-	Colombo Ord.	1¼—1½	...
24,510	,,	1/4⅝	1/4⅝	Do. 7 p.c. Pref.	20/—22/-	...
739,453	Mch. 26	-/11.48	-/11.48	Colonial Gas Assn. Ltd. Ord. ...	14/6—16/6	...
296,144	,,	1/3.30	1/3.30	Do. 8 p.c. Pref.	20/—22/-	...
1,775,005	Jan. 29	4	2	Commercial Ord.	45—50	...
140,000	Feb. 19	4	4	Do. 4 p.c. Red. Pref. ...	87—92	...
620,000	Dec. 11	3	3	Do. 3 p.c. Deb.	62—67	...
286,344	Feb. 19	5	5	Do. 5 p.c. Deb.	97—102	...
200,000	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	93—98	...
807,560	Feb. 12	7	7	Croydon sliding scale	95—100	−2
644,590	,,	5	5	Do. max. div.	85—90	...
620,385	Dec. 7	5	5	Do. 5 p.c. Deb.	100—105	−2
208,660	Feb. 19	5	5	Dudley, Brierley Hill & Dist. Ord.	98—103	...
82,275	,,	5	5	Do. 5 p.c. Con. Pref. ...	93—98	...
79,000	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	93—98	...
239,000	Jan. 29	5	88/6	East Hull Ord. 5 p.c.	70—80	...
187,215	Feb. 12	5⅝	5⅝	East Surrey Ord. 5 p.c. ...	93—98	...
176,211	Dec. 18	5	5	Do. 5 p.c. Deb. ...	100—105	...
250,000	Nov. 13	8	4	Gas Consolidation Ord. 'B' ...	15/—17/-	...
250,000	May 13	4	4	Do. 4 p.c. Red. Cum. Pref.	15/—17/-	...
19,152,410	Jan. 29	5⅜	3⅜	Gas Light & Coke Ord. ...	11/9—12/9a	−/3
2,600,000	,,	3½	3½	Do. 3½ p.c. max.	58—63	...
4,477,106	,,	4	4	Do. 4 p.c. Con. Pref. ...	82—87	−2
2,993,000	Jan. 2	3¾	3¾	Do. 3¾ p.c. Red. Pref. ...	86—91	...
8,602,497	June 3	3	3	Do. 3 p.c. Con. Deb. ...	70—75*	−1
3,642,770	,,	5	5	Do. 5 p.c. Red. Deb. ...	100—105*	−2
3,500,000	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	98—103*	−2
700,000	Mch. 11	3½	3½	Do. 3½ p.c. Red. Ded. ...	87—92	...
270,466	Feb. 19	6	6	Harrogate New Cons.	93—98	...
157,500	Apl. 8	‡1/-	‡1/-	Hong Kong and China Ord. ...	½—¾	...
5,600,000	May 13	4	8	Imperial Continental Cap. ...	48—53	−1½
172,810	Jan. 29	3½	3½	Do. 3½ p.c. Red. Deb. ...	70—75	−5
63,480	Dec. 18	3	3	Maidstone 3 p.c. Deb.	55—60	...
45,000		†10	†8	Malta & Mediterranean ... Metropolitan (of Melbourne) ...	92—102	...
392,000	Apl. 1	5½	5½	5½ p.c. Red. Deb.	95—100	...
231,977	Feb. 19	5	5	M.S. Utility 'C' Cons.	77—82	...
968,658	,,	4	4	Do. 4 p.c. Cons. Pref. ...	83—88	...
390,076	Dec. 18	4	4	Do. 4 p.c. Deb. ...	87—92	...
148,955	Dec. 18	5	5	M.S. Utility 5 p.c. Deb. ...	103—108	...
125,000	Jan. 2	3½	3½	Do. 3½ p.c. Red. Bds. ...	90—95	...
675,000	May 6	†4	†4	Montevideo, Ltd.	58—63	...
250,000	Mch. 18	7½	5⅞	North Middlesex 6 p.c. Con. ...	103—108	...
396,160	Jan. 29	5	5	Northampton 5 p.c. max. ...	97—102	...
300,000	Apl. 29	9	7	Oriental, Ltd.	113—118	...
468,537	June 3	7	8	Plymouth & Stonehouse 5 p.c.	115—120*	−3
621,667	Feb. 5	8½	8½	Portsmouth & Gosport Cons.	110—115	...
241,446	,,	5	5	Do. 5 p.c. max.	85—90	...
73,350	,,	5	5	Do. 5 p.c. Pref.	88—93	−2
75,000	,,	4	4	Do. 4 p.c. Pref.	75—80	...
114,000	Feb. 5	5	5	Preston 5 p.c. Pref.	88—93	...
247,966	Dec. 18	4	4	Primitiva 4 p.c. Cons. Deb. ...	93—98	...
625,959	Jan. 15	4	4	Do. 4 p.c. Red. Deb. ...	91—96	...
15,000	Mch. 11	6	6	San Paulo 6 p.c. Cum. Pref. ...	7⅛—8½	...
441,275	Apl. 29	1/1⅛	1/1⅛	Severn Val. Gas Cor. Ld. Ord.	16/6—18/6	...
460,810	Mch. 11	-/10⅝	-/10⅝	,, ,, 4½ p.c. Cum. Pref. ...	16/6—18/6	...
133,201	Feb. 12	8¼	5	Shrewsbury 5 p.c. Ord. ...	105—115	...
9,000	June 5	‡4	‡4	South African Ord.	4—5	...
1,996,297	Apl. 29	1/2⅛	1/	South East'n Gas Cn. Ld. Ord.	12/6—14/6	−/6
1,000,000	Mch. 4	-/10⅛	-/10⅛	Do. 4½ p.c. Red. Cum. Pref.	14/—16/-	−1/6
769,191	,,	4	4	Do. 4 p.c. Cum. Pref. ...	13/—15/-	−1/-
450,000	Feb. 12	4	4	Do. 4 p.c. Red. Deb. ...	95—100	...
150,000	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	89—94	...
6,709,895	,,	5	4	South Met. Ord.	52—57	−3
1,135,812	,,	6	6	Do. 6 p.c. Irred. Pref. ...	109—114	...
850,000	,,	4	4	Do. 4 p.c. Irred. Pref. ...	82—87	...
1,895,445	Dec. 27	3	3	Do. 3 p.c. Deb.	70—75	−2
1,000,000	Jan. 15	5	5	Do. 5 p.c. Red. Deb. ...	98—104	−4
600,000	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	92—97	...
1,543,795	Feb. 5	6	3	South Suburban Ord. 5 p.c. ...	75—80	...
512,925	,,	5	5	Do. 5 p.c. Pref.	93—98	...
500,000	,,	4	4	Do. 4 p.c. Pref.	82—87	...
250,000	,,	3½	3½	Do. 3½ p.c. Red. Pref. ...	85—90	...
888,587	Dec. 11	5	5	Do. 5 p.c. Deb.	100—105	...
250,000	,,	4	4	Do. 4 p.c. Deb.	87—92	...
200,000	Feb. 12	3½	3½	Do. 3½ p.c. Red. Deb. ...	87—92	...
427,859	Apl. 15	-/9⅜	1/2⅜	S. Western Gas & Water Ord.	13/—15/-	...
160,523	,,	-/10⅛	-/10⅛	Do. 4½ p.c. Red. Cum. Pref.	15/—17/-	−1/6
110,000	Dec. 18	4	4	Do. 4 p.c. Red. Deb. ...	90—95	...
750,541	Feb. 5	5	5½	Southampton Ord. 5 p.c. ...	77—82	+2
148,836	Dec. 27	4	4	Do. 4 p.c. Deb.	87—92	...
350,000	Feb. 12	5½	5½	Swansea 5½ p.c. Red. Pref. ...	97—102	...
200,000	Dec. 18	3½	3½	Do. 3½ p.c. Red. Deb. ...	90—100	...
1,076,490	Feb. 26	6½	5	Tottenham and District Ord....	90—95	...
409,835	,,	5½	5½	Do. 5½ p.c. Pref.	102—107	...
62,235	,,	5	5	Do. 5 p.c. Pref.	95—100	...
453,380	Dec. 11	4	4	Do. 4 p.c. Deb.	87—92	...
1,247,505	May 20	4	6	U. Kingdom Gas Cor. Ord. ...	13/—15/-	−/6
1,085,952	May 13	4½	4½	Do. 4½ p.c. 1st Cum. Pref. ...	14/6—16/6	...
772,709	,,	4	4	Do. 4 p.c. 1st Red. Cum. Pf.	14/—16/-	...
745,263	Dec. 18	4½	4½	Do. 4½ p.c. 2nd Non-Cum. Pf.	13/—15/-	...
1,093,656	Mch. 18	3½	3½	Do. 3½ p.c. Red. Deb. ...	83—88	...
378,106	Mch. 11	7	7	Uxbridge, &c., 5 p.c.	95—100	...
133,010	,,	5	5	Do. 5 p.c. Pref.	95—100	...
1,371,138	Feb. 5	6½	3½	Wandsworth Consolidated ...	68—73	...
2,525,768	,,	4	4	Do. 4 p.c. Pref.	80—85	...
1,343,964	Dec. 18	5	5	Do. 5 p.c. Deb.	100—105	...
383,745	,,	4	4	Do. 4 p.c. Deb.	87—92	...
400,000	,,	3¾	3¾	Do. 3¾ p.c. Red. Deb. ...	90—95	...
558,342	Jan. 29	6¾	6	Watford and St. Albans Ord. ...	95—100	...
200,000	,,	5	5	Do. 5 p.c. Pref.	95—100	...
200,000	,,	5¼	5¼	Do. 5¼ p.c. Pref.	100—105	...
200,000	,,	4	4	Do. 4 p.c. Rd. Pf. (1973/8)	85—90	...
100,000	,,	33/4⅝	4	Do. 4 p.c. Red. Pf. (1959)	93—98	...
200,000	Dec. 11	3½	3½	Do. 3½ p.c. Red. Deb. ...	87—92	...

a.—The quotation is per £1 of Stock. * Ex. Div. † Paid free of income-tax. ‡ For year. § Actual.

Supplementary List and Provincial Exchanges overleaf.

STOCK AND SHARE LIST—Contd.

Supplementary List, not Officially Quoted, London

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Nominal Quotations June 7.	Rise or Fall on Week.
202,152	Mch. 18	5	5	Ascot Ord.	80—85	...
128,182	Dec. 27	5	5	Do. 5 p.c. Pref. ...	88—93	...
31,035	Mch. 4	-/9 3/8	-/9 3/8	Associated Utilities 4 p.c. Pref.	15/—17/-	...
100,000	Dec. 18	3½	3½	Do. 3½ p.c. Red. Deb. ...	90—95	...
17,000	Feb. 19	8	8	Bognor Orig. Ord. 'A' ...	102—112	...
62,210	,,	8	8	Do. New Add. 'A' ...	102—112	...
87,160	,,	7	7	Do. New 7 p.c. max. ...	95—105	...
37,440	Jan. 29	10	10	Cam. Univ. & Town 10 p.c. max.	145—155	...
125,970	,,	7	7	Do. 7 p.c. max.	110—120	...
39,025	,,	5	5	Do. 5 p.c. max.	80—90	...
96,410	Jan. 29	4½	4½	Cardiff 4½ p.c. Pref. ...	90—95	...
55,520	Feb. 19	6	6	Colchester 6 p.c. Pref.	100—105	...
90,550	Mch. 18	5	5	Do. 5 p.c. Deb. ...	98—103	...
150,000	Feb. 12	4	4	Croydon 4 p.c. Pref.	82—87	...
130,000	Dec. 27	4	4	Do. 4 p.c. Deb.	87—92	...
65,000	Mch. 4	7½	6 37/40	Eastbourne 'A' 5 p.c.	105—110	...
198,000	,,	6	5 39/40	Do. 'B' 3½ p.c.	93—98	...
112,312	,,	5	5	Do. 5 p.c. Pref.	90—95	...
130,000	Dec. 18	5	5	Do. 5 p.c. Deb.	98—103	...
130,500	Feb. 19	7½	7½	Exeter New Ord. (£10) ...	12—14	...
24,000	Aug. 21	8½	8½	Gt. Yarmouth 8½ p.c. max. (£30)	15—20	...
59,400	,,	7½	7½	Do. 7½ p.c. max. (£30) ...	10—15	...
51,160	Dec. 11	5½	5½	Do. 5½ p.c. Deb.	102—107	...
152,600	Feb. 26	8	9	Guildford Cons.	110—120	...
54,055	,,	5	5	Do. 5 p.c. Pref.	90—95	...
68,250	Dec. 11	5	5	Do. 5 p.c. Deb.	103—108	...
156,600	Feb. 19	7	5	Hampton Court Cons. ...	75—85	...
86,046	June 19	‡4½	‡5	Holyh'd&N.W.G.&W.Cpn.Ord.	13/6—15/6	...
80,000	Feb. 12	4	4	Lea Bridge 4 p.c. Pref.	75—80	...
60,000	,,	6	6	Do. 6 p.c. Pref.	105—115	...
94,876	Dec. 18	4	4	Do. 4 p.c. Deb.	88—93	...
73,620	Mch. 18	8½	8½	Luton Cons. 'A'	115—125	...
107,960	Feb. 26	4	5½	Mid Kent Ord. (£10)	7½—8½	...
230,940	Feb. 5	10	10	Oxford & District Ord. ...	135—145	...
47,112	,,	5	5	Do. 5 p.c. Pref.	85—90	...
50,000	,,	6	6	Do. 6 p.c. Red. Pref. ...	100—105	...
126,193	May 13	7½	7½	Peterborough Ord.	138—148	...
64,990	Mch. 18	7	7	Redditch Ord.	100—110	...
166,850	Feb. 19	8	8	Romford Ord.	108—118	...
60,000	,,	4	4	Do. 4 p.c. Pref.	85—90	...
44,000	Mch. 18	5	5	Do. 5 p.c. Deb.	97—102	...
25,570	Feb. 12	5½	5½	Rugby 5½ p.c. Pref.	100—110	...
25,000	,,	6	6	Do. 6 p.c. Red. Pref. ...	100—105	...
42,750	De.. 11	5½	5½	Do. 5½ p.c. Deb.	105—110	...
110,950	Feb. 26	8	8	Ryde Ord.	100—110	...
270,086	Mch. 18	7	7	Slough Ord.	98—103	...
21,000	Dec. 11	5	5	Do. 5 p.c. Deb.	98—103	...
28,872	May 13	5½	5½	S. Midland Gas Cpn. Ltd. Ord.	14/—16/-	...
28,866	Mch. 18	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	14/—16/-	...
127,228	Feb. 19	5	7	Swindon Cons.	75—80	...
60,425	Dec. 18	5	5	Do. 5 p.c. Deb.	95—100	...
64,380	,,	5	5	Torquay & Paignton 5 p.c. Pref.	85—90	...
130,000	Feb. 12	5	5	Wakefield Ord.	85—95	...
81,650	,,	5	5	Do. 5 p.c. max.	75—80	...
82,000	Jan. 29	6	6	Weymouth Ord.	82—87	...
273,626	Feb. 12	7	7	Wolverhampton Cons. Ord. ...	115—120	...
98,384	,,	6	6	Do. 6 p.c. Pref.	105—115	...
160,000	Dec. 18	5½	5½	Do. 5½ p.c. Red. Deb. ...	100—105	...
106,490	Mch. 18	5½	5½	Wrexham Ord	75—85	...
90,000	Dec. 18	5	5	York 5 p.c. Red. Deb.	95—100	...
133,640	Feb. 19	6	6	Yorktown (Cam.) 5 p.c. Cons.	82—87	...
120,000	,,	5	5	Do. 5 p.c. Pref.	85—90	...
35,000	Dec. 18	5½	5½	Do. 5½ p.c. Deb.	105—110	...

BRISTOL EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations June 7.	Rise or Fall on Week.
347,756	Feb. 1	5	6	Bath Cons.	105—107	...
1,667,250	Feb.	5	5	Bristol, 5 p.c. max.	98—102	-3
120,420	Dec.	4	4	Do. 1st 4 p.c. Deb.	98—101	...
415,250	,,	4	4	Do. 2nd 4 p.c. Deb. ...	98—101	...
328,790	,,	5	5	Do. 5 p.c. Deb.	115—117	...
274,000	Feb. 26	5	5	Newport (Mon.) Ord.... ...	91—94	...
13,200	Mch. 26	7	8½	Pontyp'l Gas & W. 10 p.c. 'A'	11½—12½	...
13,600	,,	5	6	Do. 7 p.c. 'B'	10—11	...
40,000	,,	5	6	Do. 7 p.c. 'C'	10—11	...
140,778	Feb. 12	5	5	Weston-super-Mare Cons. ...	92—96	...
64,338	Dec. 27	4	4	Do. 4 p.c. Deb.	90—95	...
33,340	,,	7½	7½	Do. 7½ p.c. Deb.	140—150	...

LIVERPOOL EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations June 7.	Rise or Fall on Week.
157,150	Feb. 5	5	6½	Chester 5 p.c. Ord.	98—101	...
92,500	Dec. 18	4	4	Do. 4 p.c. Pref.	84—88	...
36,430	,,	3½	3½	Do. 3½ p.c. Deb.	85—88	...
41,890	,,	4	4	Do. 4 p.c. Red. Deb. ...	95—99	...
2,167,410	Feb. 19	6	6	Liverpool 5 p.c. Ord.	107—109	...
245,500	Dec. 18	5	5	Do. 5 p.c. Red Pref. ...	99½—102½	...
306,083	July 17	4	4	Do. 4 p.c. Deb.	98—101	...
106,280	Feb. 5	10	8	Preston 'A' 10 p.c.	160—170	...
188,219	,,	7	7	Do. 'B' 7 p.c.	115—125	...

NEWCASTLE EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations June 7.	Rise or Fall on Week.
122,577	Feb. 19	7	7	Blyth 5 p.c. Ord.	113—118	...
732,000	Feb. 19	4	4	Hartlepool G. & W. Co. & New	65—67	...
2,430,267	Feb. 5	5	5 7/16	Newcastle & Gateshead Con.	17/6—18/6a	-9
682,856	,,	4	4	Do. 4 p.c. Pref.	85—86	-½
776,706	Dec. 27	3½	3½	Do. 3½ p.c. Deb.	82—87	...
277,285	April 24	5	5	Do. 5 p.c. Deb. '43	97—102	...
332,351	Feb. 5	6	6	Sunderland 6 p.c. max. ...	111—113	...

NOTTINGHAM EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations June 7.	Rise or Fall on Week.
542,270	Feb. 12	6	9	Derby Con.	103—108	...
55,000	Dec. 18	4	4	Do. 4 p.c. Deb.	98—103	...
20,000	Dec. 18	5	5	Long Eaton 5 p.c. Pref. ...	9—11	...
80,000	,,	5	5	Do. 5 p.c. Deb. ...	100—105	...

SHEFFIELD EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations June 7.	Rise or Fall on Week.
10,000	Feb. 19	10	10	Great Grimsby 'A' Ord. ...	170—180	...
6,500	,,	10	10	Do. 'B' Ord. ...	170—180	...
79,000	,,	10	10	Do. 'C' Ord. ...	160—170	...
1,806,339	Feb. 26	6½	6½	Sheffield Cons.	124—126	-1
95,000	Jan. 2	4	4	Do. 4 p.c. Deb.	98—100	...

a The quotation is per £1 of Stock.
* Ex. div. ‡ For year.

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